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The American Biology Teacher

NOVEMBER, 1960 VOLUME 22, NO. 8

Animal Experimentation in the High School

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TABLE OF CONTENTS

The New Look in Science Education 469
Arthur S. Flemming
The Process of Science 469
Orr E. Reynolds
Apologies for a Slip 470
Plastic Skull 470
A Look at Biology 470
Small Animals in the Classroom 471
Dietrich C. Smith
The American Biology Teacher Editorial Staff 477
Code for Use of Animals in High School Biology Courses 478
Survival in the Sea 478
The Green Drink 478
John Brainerd
The Abuse of Animals in the Classroom and How It Can Be Avoided 479
Animal Welfare Institute
Some Feeding Problems Solved 483
Sister Mary Adelaide
Additional Reports on Experimentation 484
A Solution to the Live Animal Problem in High School 485
Mary G. Gibbon
Biological Program of Spaceship 486
Academician N. M. Sisakyan
New Anti-Serum Destroys Sympathetic Nervous System 488
Building Animal Cages and Containers for Classroom Use 489
Paul W. Welliver
Looking Ahead in Science 493
Fellowships 493
Dedication Ceremonies 493
Heredity by TV 493
Live Animal Study in the Beginning Zoology Course 494
A. M. Holmquist
Radiation and High School Teaching 496
Donald J. Fluke
Journal of Biology—1960 497
Report on a Florida Science Study Program 498
Doris Timpano
Audio-Visual Report 500
Conservation Publication 500
New Bibliography 500
Slippery Skins of Germs 500
Chemical Trap 500
Nominations for 1961 Officers 501
Book Reviews 504

Cover Picture

This picture of a classroom scene was taken by Paul Welliver in Roosevelt Jr. High School, Williamsport, Penn., in connection with his article carried elsewhere in this issue.

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The New Look in Science Education

ARTHUR S. FLEMMING
Secretary of Health, Education, and Welfare

Elementary and secondary education in the United States is in the midst of a healthy ferment. Everywhere, we see new approaches to curriculum development, new methods of classroom teaching, and new ways of presenting traditional subject matter.

This process of innovation is perhaps most exciting—and most promising—in the field of science. In many schools at the high school and junior high school level, experimentation is supplementing lectures. Youngsters are gaining a deeper understanding of the meaning of inquiry, observation, and analysis—the very essence of the scientific method.

Already high school science projects, fairs, and similar undertakings have produced impressive results. Our young students are demonstrating great insight and keenness of mind and are already making new contributions to scientific knowledge.

Certainly, such promise should be encouraged. It might well be extended, under careful supervision, to as many scientific disciplines as possible. Appropriate research projects in the biological and social sciences can be as exciting and rewarding to high school students as experiments in the physical sciences.

Animal experimentation is at the heart of research in the biological and life sciences. Considerable study, of course, needs to be done on the extent and appropriate nature of such experimentation at the junior and senior high school levels. Many animal studies are too complex for youngsters and, of course, it is important for young students to be thoroughly trained in the humane care of laboratory animals. Thus, biological experiments in secondary schools should be conducted under very careful supervision and guidance.

Nonetheless, I am confident that suitable projects in this field can be developed for students in the junior and senior high schools. Indeed, this kind of supervised training can help develop a more profound appreciation of the value and dignity of life. And it can help advance a vigorous brand of science education in the United States.

The Process of Science

ORR E. REYNOLDS, *Director*
Office of Science, The Department of Defense

No threat to the national defense is greater than the possibility that a potential enemy nation might beat the United States to revolutionary scientific discoveries that could tip the balance of world power. Future discoveries comparable to the discovery of nuclear fission will take place. Will they take place in the United States or elsewhere? The security of the United States depends significantly upon the answer.

Scientific leadership must be, therefore, a major element of over-all defense policy for the United States.

It is the policy of the Department of Defense to concern itself broadly with the scientific resources of the nation.

National security is, however, but one of the blessings of a fertile environment for science in America. Science is the process of obtaining factual knowledge about any conceivable thing. Therefore every aspect of life is or can be affected by science. Yet few people understand the nature and the thrilling potentials of science. Understanding science should not be difficult because the fundamental motivation behind science has been the yeast of human progress since antiquity—the curiosity of man for knowledge about himself and his environment.

In primitive societies explanations of natural phenomena—including human behavior—was usually based on an assumption

of supernatural forces. The assignment of supernatural causes for natural phenomena stemmed from the imagination of man based on his observations of nature. These pre-scientific ideas are not greatly different from the hypotheses which constitute the first step in scientific research. The difference between science and other processes of intellectual invention is that to scientists an idea is not regarded as a fact or as a truth until it has met rigorous tests of validity.

The scientist calls a raw idea a hypothesis. After the idea has gathered sound supporting evidence it becomes known as a theory. Only after some kind of direct proof has been demonstrated, is the precious label of "fact" bestowed, and even that is tentative. Scientists must always be willing to strip away the credentials of a "fact" if new, conflicting evidence appears.

So you see that the great contribution of science to human knowledge is not the ability to produce imaginative hypotheses. Rather it is the methods by which the validity of hypotheses can be tested by experiment.

Science highlights what is true in large part by revealing what is not true; i. e., what has failed the validity checks. The experimental methods of science free man from the confusing maze of conflicting opinion. It is as though the compasses by which man steered his various courses pointed helter-skelter in every way and science provided ways to test compasses.

It seems virtually certain that science will continue to exert greater and greater influence over our lives, which is to say that man will as time goes on act more and more on the basis of verifiable knowledge and less on the basis of fantasy.

I believe, therefore, that young people are not prepared for life in the modern world without having actual experience with the idea-testing experimental methods of science. Science education is inadequate if it only imparts useful facts, figures, and other ideas from the past. The student must become acquainted with science as a dynamic creative process, and he can gain this acquaintance only by conducting careful experiments himself with his own ideas.

When people deprecate the first inept experimental research of students and say, for instance, that "cancer will not be conquered in a high school or grade school laboratory," they have missed the entire point.

It is ignorance of science—the greatest force in the modern world—that must be conquered in school laboratories.

Apologies for a Slip

The May, 1960, cover picture was labeled as being a cross-section of a corn stem. Several alert readers questioned this, and on the best authority we can find, it turns out to be a cross-section of an asparagus stem. The photographer, F. Paul Ralston, Knoxville, Iowa, promises to change his slide label, and both he and the editor apologize for the mistake.

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A LOOK AT BIOLOGY

To many, biology is all so confusing,
Just hard, cold facts—not a bit amusing.
And yet it is something always around us;
The bee, the tree, the frog, and the fungus.
Don't throw up your hands in exasperation
Over all these things with no set formation.
Look at that tree and study its bark;
Find a turtle, and follow that lark.
Now you are studying biology right
By using your nose, your ears, and your sight!

Debbie White

Small Animals in the Classroom

DIETRICH C. SMITH,* *University of Maryland, Baltimore*

A simple classroom demonstration involving a study of some phase in the growth, development, behavior, or reproduction of a pair of white rats, guinea pigs, hamsters, or mice can arouse enough curiosity, stimulate enough interest, and present a great enough intellectual challenge to hold the attention of a class for months and to keep a teacher busy answering questions for the rest of the year. There is no substitute for life, and a biology class without living material is like a music class without a piano. All manifestations of life are fascinating and none should be neglected. Flowers and fruits, frogs and fish, cocoons and birds' nests, all have a place in the classroom, but none of these can be compared to the appeal of a small mammal; warm, furry, brighteyed, alive with curiosity one minute, probing every nook and cranny of his cage, and then curled up in sleep the next.

Such at least has been the experience of the Maryland Society for Medical Research which six years ago began placing small mammals in selected classrooms throughout the state and has by now sponsored over 650 animal projects in Maryland schools. With this experience behind it, the Society is in a position to evaluate its program critically. In all this time there has not been one untoward incident, not one adverse word of criticism regarding the conduct of the project from those in a position to know what was going on, teachers, parents, children, supervisors, principals, and casual visitors and onlookers. Quite the contrary, our files bulge with letters of thanks and praise from the teachers and students we have helped. We have charts, graphs, tables, and protocols, some the work of individual students, others the work of the class as a whole, sent to us each year to show us what has been done with our animals. All in all, there has been no phase of our educational program which has proved to be more rewarding and which has been received with more thanks and appreciation. It is indeed a privilege to render a service to such a devoted and enthusiastic group of teachers.

The Society is an organization dedicated to informing the public, particularly in Maryland, regarding medical research, what it has done, how it has done it, and what it might reasonably be expected to do in the future if given the kind of support it needs. The key role that animals have played and will continue to play in the almost explosive expansion of medical research characteristic of the past fifty years should be recognized and understood. One of our basic goals is to further this knowledge.

To do this effectively it seemed to us that an appreciation of the basic concepts of medical research on which our present health standards rest and on which the continued conquest of disease depends should be an integral part of every high school biology course. This means the teacher must be able to impart a knowledge of the broad principles by which science operates, the rigorous examination of data, the careful plotting of controlled experiments, and the stern discipline to which the scientist must hold himself. The biological sciences follow the same general procedures as do the physical sciences with one important exception; they deal with living things. Life is complex, and its manifestations not always predictable, probably because our knowledge is far from complete. But even so, great progress has been made in controlling its processes through the application of the experimental method. The essence of this method is the ability to do an experiment in such a way that under similar circumstances it can be duplicated exactly as described. This means precision in performance, careful planning, accurate recording of data, and above all, the use of control experiments.

What better way to illustrate these basic procedures than by doing a simple animal experiment in the classroom? In fact, this approach is so obvious and so appealing that it must occur spontaneously every year to thousands of teachers, many of whom attempt to implement their idea immediately, not

*Secretary, Maryland Society for Medical Research, Professor of Physiology and Associate Dean, School of Medicine, University of Maryland, 522 W. Lombard St., Baltimore 1, Maryland.

always with favorable results. The widespread interest in this area points up the need for control, regulation, and above all, a mechanism for giving practical advice.

Anyone who has ever worked in a medical research laboratory is sooner or later asked to lend, give or even sell a rat, mouse, or a guinea pig to some enterprising teacher with whom he may or may not be personally acquainted. The Maryland Society for Medical Research was no exception; in fact, the number of requests was such that it was obvious some policy would have to be adopted to deal with it. Thus our Small Animal Classroom Project was born, for, recognizing the need and realizing the necessity for keeping the enthusiasm of potential biologists within reasonable bounds, the Society decided in 1955 to put the placement of animals on some other basis than a casual, informal one. The response was immediate and enthusiastic, unassisted by any fanfare, ballyhoo, or publicity, it grew steadily until today it is one of our major activities.

This is the way it works. A teacher wishing animals files an application indicating the animals he wishes and the type of experiment he intends to perform. On the application, the choice of the experiment is limited to either a simple dietary experiment on a vitamin deficiency, thiamine in the rat, or ascorbic acid in the guinea pig, or a genetic experiment on the inheritance of albinism in mice. Learning experiments with rats or mice, involving the use of a maze, have also been tried with success. Time has shown this choice to be more than adequate, and it is not necessary to promote sensational experiments, such as placing mice in rockets, attempting to repeat surgical experiments, or trying to find a cure for cancer. In fact, such experiments should be done at the high school level only with great caution and under careful supervision lest they lead to unfortunate results and undesirable publicity. They should never be undertaken unless they can be continually supervised by a well qualified biologist. It is because of the danger of abuses that the Society feels it essential that they try to bring some order and reason into what could easily become a chaotic situation if not guided by hands experienced in animal experimentation.

All teachers requesting a project must sign the following agreement:

> "I agree that at all times it will be my responsibility to see that the animals entrusted to my care are properly treated and housed in accordance with enclosed copy of 'Guiding Principles in the Use of Animals by Secondary Schools,' and that no experiment will be performed upon them other than authorized by the MARYLAND SOCIETY FOR MEDICAL RESEARCH and that directions for the experiment supplied by the M.S.M.R. will be meticulously followed in order to avoid suffering by the animals. It is also understood that the M.S.M.R. assumes no responsibility for any property damage or personal injury that might be caused by the animal. I also agree that a representative of the M.S.M.R. shall have the privilege of visiting my classroom during hours arranged with me in advance to observe how the project is progressing. I understand I am to call the M.S.M.R. if the animals become sick, injured, or if I need any advice regarding their care, disposal or the performance of the experiment. The MARYLAND SOCIETY FOR MEDICAL RESEARCH shall have the right to copy and reproduce at their expense any of the data obtained or any photographs taken of the experiments."

No experiment involving dangerous drugs, chemicals, radioactive isotopes, or carcinogens has ever been approved, nor is it likely to be. The society feels that the classroom is not the place for projects of this type which should instead, if performed by students, be done in the laboratory of a qualified investigator where he can exercise day to day supervision. Note that the agreement requires adherence to the "Guiding Principles In The Use Of Animals By Secondary Schools" as approved by the National Research Council and the National Academy of Sciences. These Guiding Principles are as follows:

> "1. The basic aim of scientific studies that involve animals is to achieve an understanding of life, and to advance our knowledge of the processes of life. Such studies lead to a respect for life.
> 2. A qualified adult supervisor must assume primary responsibility for the purposes and conditions of any experiment that involves living animals.
> 3. No experiment should be undertaken that involves anesthetic drugs, surgical procedures, pathogenic organisms, toxicological products, carcinogens, or radiation, unless a biologist, physician, dentist, or veterinarian trained in the experimental procedure involved assumes direct responsibility for the proper conduct of the experiment.
> 4. Any experiment must be performed with the animal under appropriate anesthesia if the pain involved is greater than that attending anesthetization.
> 5. The comfort of the animal used in any study shall be a prime concern of the student investigator. Gentle handling, proper feeding, and pro-

vision of appropriate sanitary quarters shall be strictly observed at all times. Any experiment in nutritional deficiency may proceed only to the point where symptoms of the deficiency appear. Appropriate measures shall then be taken to correct the deficiency, or the animal killed by humane methods.

6. All animals used must be lawfully acquired in accordance with state and local laws.

7. Experimental animals should not be carried over school vacation periods unless adequate housing is provided and a qualified caretaker is assigned specific duties of care and feeding."

However, it should not be thought we are completely rigid in the matter of "off-beat" experiments or unsympathetic toward anything but the tried and true. If by chance a teacher wishes to elect something else than stated in the application, a project proposal can be submitted with the application. If it is feasible, if it does not violate any of the principles regulating proper care of animals, and if the teacher has had sufficient background in biology to inspire confidence in his ability to carry through such a project, animals will be supplied, food and special diets provided when available, and all other possible assistance given, including suggestions as to what scientists in the area might be approached for expert guidance and help.

Such projects serve well in encouraging potential research biologists, and they should be given all assistance possible. Often times they win prizes at science fairs and attract a great deal of favorable publicity, but because they are usually done by one student working on his own, they are limited in scope so far as bringing home the facts of animal experimentation to all of the students in a classroom or a school. For this purpose the

Figure 1. Students inspecting a guinea pig preparatory to beginning dietary study.

Figure 2. Weighing the subject of a nutrition experiment.

simpler types of experiments are much more rewarding since they become a joint cooperative classroom exercise. They can be undertaken with a reasonable expectation of success and at the same time teach some basic principles regarding controlled experimentation and the humane care of animals.

Once a project has been set up in the classroom, the Society does not feel that it can now proceed to forget it. Quite the contrary, we acknowledge a continuing responsibility and to discharge this obligation we have established a Visiting Committee, one member of which visits each classroom in the immediate area at least once during the year to observe how the project is progressing and to offer help and advice if needed. In addition, the teachers are encouraged to call us at any time if assistance is needed, and there are many who do, and at the end of the year to submit a report on what was accomplished. In this way we have accumulated an impressive collection of growth curves, pedigree charts, pictures, and records which keep us well informed about what is being done.

Not only are the teachers supplied with animals and food but also with complete directions for the care and feeding of the animals entrusted to them, as well as complete directions for performing the experiment chosen, and for making whatever equipment is needed. Except for a good kitchen scale which should read to a fraction of an ounce, or better yet be calibrated to read in grams, all of the equipment required can be made easily and cheaply. The manufacture of cages poses no problem, and directions for making

Figure 3. Recording data for a nutrition experiment.

these are supplied to all teachers. Hardware cloth and tin pie plates serve very nicely as raw materials and can be put together in the proper fashion by even the least mechanically inclined individual. Glass aquarium bowls make excellent homes for mice. Even bird cages of one kind or another have been used on occasion. Bedding can be obtained from a variety of sources if wooden shavings are not available. Old newspapers, paper towels, toilet paper, and even string all make excellent nesting material. In fact, setting up and equipping the experiment becomes one of the more challenging and interesting features of the work, and it is often amazing as well as very heartening to see the ingenuity and skill which goes into such efforts.

The effects of a small animal in a classroom are many and not always immediately apparent. The most important objective is to give the student some understanding as to how science works, particularly what it can and cannot do, and how important it is to plan carefully if valid results are to be achieved. A broad understanding of the scientific method, its limitations, is an educational responsibility with high priority in our society today, and it is certainly not too early to begin instruction in this area in the high school classrooms. On the one hand, many of our citizens fear science and scientists, while on the other, many—and the two classes do not exclude each other—look to science to solve all our problems from over-population to cancer. Obviously a small animal project is not going to bring about insight and comprehension to all overnight, but it will serve to bring home to many some of the techniques used in animal experimentation and perhaps stimulate a few to pursue the matter further.

In doing a dietary experiment the growth of one or more pairs of carefully selected animals is observed and recorded. No experiment appears to be simpler, yet there are pitfalls. First of all, it should be established that the control and experimental animals both grow at the same rate on the same diet and under the same environmental conditions. It is surprising how often this simple elementary fact is overlooked and a preliminary series of observations not made on the animals. Once the experiment is in progress is any observed difference in growth actually due to the difference in diet? If the animals have been kept together in a single cage does the necessary separation to insure that they get separate diets in itself introduce a new factor into the environmental situation that might or might not affect growth? Is any decrease in growth rate in the experimental animal the result of the absence of some nutritional factor, or is it due to some change in the palatability of the diet? Is the effect reversible? This last question should present no difficulties if the experimental animal is placed on the adequate diet, and the control on the inadequate diet after the effect on weight is clearly developed in the first. The teacher is always cautioned to continue the experiment only to the point where a difference in growth is noticeable, and above all, not to permit the experiment to proceed to the point where lesions may occur or where paralysis may set in. Finally, do both animals grow in a normal fashion after they have both experienced a period on a deficient diet?

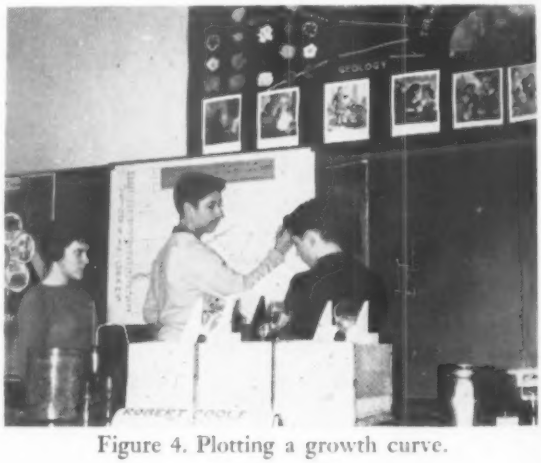

Figure 4. Plotting a growth curve.

Such an experiment as this requires careful planning and takes at least three months to perform successfully. Students in any classroom where this has been done will certainly have an appreciation of the thought and preparation that is required to bring such a project to a successful conclusion. Here of course the teacher plays an important role in pointing out the necessity for such care as well as the significance and importance of control experiments.

There are two types of experiments on simple dietary deficiencies that are relatively easy to perform within the time available to the average classroom. One is the study of thiamine deficiency which usually manifests itself by loss of appetite and weight loss in a rat within two to three weeks after going on the diet. The deficient diet is easy to make by placing ordinary rat pellets in an autoclave under steam pressure for about five hours. This actually can be done in an ordinary steam pressure cooker by anyone who has a reasonable understanding of how to proceed. In practice, however, the Society supplies for the experiment, along with the rats, autoclaved pellets in which thiamine has been destroyed. The other dietary project is an ascorbic acid deficiency study in guinea pigs performed by feeding guinea pigs a pellet diet unsupplemented by fresh green leaf vegetables. Most pellet diets for guinea pigs either do not contain ascorbic acid or contain it in inadequate amounts because the heating and subsequent drying of the alfalfa from which the pellets are made destroys the ascorbic acid. Thus guinea pigs kept on a pellet diet are always given a supplement of greens if they are to stay in good health. Consequently, a pair of guinea pigs, one on pellets alone, and one on pellets plus lettuce, will usually show a divergence in growth within two to three weeks. If they do not, it is probably because the pellets contain enough ascorbic acid to prevent a weight loss. If this is so the difficulty can usually be remedied by drying the pellets in a hot oven for several hours or exposing them to the direct rays of the sun for the same length of time. Again, the experiment should proceed only to the point where there is a clear cut difference in weight between experimental animal and control.

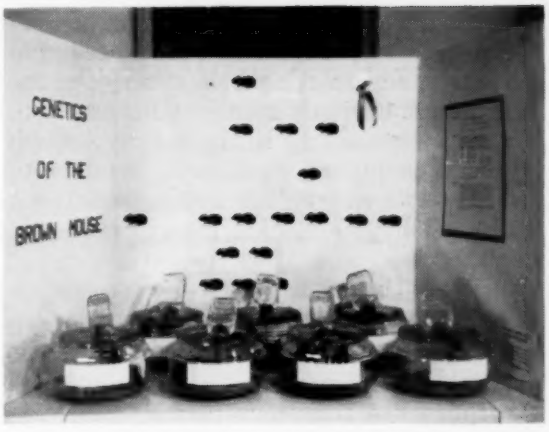

Figure 5. A Science Fair prize for a genetic experiment on albinism in mice.

When this is established the diets should be reversed.

Another type of classroom project which is simple to perform, since it does not involve any sort of experimental procedure other than letting nature take its course and which takes several months to perform, is of course a genetic experiment. A classroom is supplied with a pair of mice, one an albino, and the other a brown or black coated animal heterogygous for albinism. The Society breeds such animals and keeps a stock on hand. If the two are mated there should be among the progeny, according to the Mendelian laws of inheritance, an equal number of albino and dark coated mice, and, within the limits of probability, such is usually the case. We can also supply an albino mouse and a mouse homogygous for black or brown coat, and by breeding such a pair, and obtaining all black or brown progeny, and then inbreeding these, it can be shown how a recessive character appears in the second generation after being completely hidden in the first. Other types of matings are also possible, such as homozygous brown crossed with a heterogygous brown.

There is no need to dwell on the interest which a prospective litter of mice will arouse in a classroom nor the satisfaction and even pride in their ultimate arrival. Once on the scene, there is ample opportunity to discuss their growth, watch the gradual appearance of fur, the opening of the eyes, the first awkward attempts to walk, and the final attainment of complete independence and

adulthood. These progeny in turn can be bred as soon as they matured, usually in eight to ten weeks, and so the whole cycle of mammalian reproduction is open for demonstration. If such an experiment is begun early enough in the school year, there will be time to breed several generations and to work out the inheritance of albinism in various genetic combinations.

Besides the immediate purpose of the experiment, other lessons can be learned as well, not the least of which is the proper care of animals, knowledge which can be applied by the students to their own pets at home. All children keep pets at some time or other in their lives, and most parents are only too well aware that these same children can be woefully irresponsible when it comes to seeing their pets are properly housed and fed. We do not pretend a small animal classroom project will automatically correct this state of affairs, but it certainly affords an opportunity for the teacher to bring home to the child some elementary principles regarding animal care. There is also the added excitement and interest in an experiment that involves a living animal. Children come to be concerned about their charges in a manner quite different from what they feel about a chemical reaction in a test tube, the motion of a pendulum, or the dried up exoskeleton of a crayfish, important as these things may be. Here is a wonderful opportunity to teach the principles of humane care of animals, to bring home the thought that no one is more concerned about this than the research scientist, who quite apart from his natural sympathy, knows the success of his investigations depends upon good health in his animal colony.

Then too a small animal project points up the necessity of careful planning and thinking ahead. The organization of the experimental team is important. Who is responsible for cleaning and feeding, who is responsible for weighing, who keeps the record and plots the graphs? Such tasks should be, and usually are, rotated among the students so that all will have a share in all phases of the investigation. From time to time there should be informal progress reports and discussions of the data to date. When the project is complete, a formal presentation of the data before the entire class, or even the entire school, with charts and graphs carefully worked up, is a real challenge to some enterprising and promising person in the group and should be undertaken if at all possible.

Finally, anyone who has ever done scientific investigation knows that research does not always run smoothly. Animals get sick, they die, they do not behave in the manner expected of them. The records may get mixed up, directions are misinterpreted, a sudden snow storm may close the schools for a day or two. All these things, and many others, can happen, and preparations must be made to deal with them when they occur and to guard against their happening in the first place. One false move may destroy the validity of months of work. Only careful planning, unremitting caution, and constant vigilance will insure a successful outcome. This in itself is a lesson of great value, and even if an experiment should "fail," much can be learned from the attempt. If nothing else, it should dispel any idea scientists get their results by waving magic wands. Sometimes the final report of an experiment sounds deceptively simple, so much so in fact, that it makes research seem easy. On the other hand, some people attribute an esoteric quality to research beyond the reach of the ordinary mind, and projects such as these should dispel such ideas since they show that the application of thought and common sense will make the basic principals involved comprehensible.

In spite of all of these obvious virtues there are unfortunately those who violently object to placing small animals in the classroom. Nothing seems to arouse the fury of the antivivisectionists and their fellow travellers more. Many of these latter are estimable but misguided people who loudly profess their devotion to medical research but who somehow, whenever the chips are down, are found on the side of those who would cripple it with unfavorable legislation. Recently articles have appeared in national magazines by journalists who seem to have been taken in by these people, either through misguided zeal on their part, or by failing to resist the temptation to write a sensational if grossly distorted story. There is little point in answering such articles directly. The Maryland Society for Medical Research believes the facts should speak for themselves, and they

point with pride to their own experience in placing animals in the classroom. This is an area that requires careful thought and intelligent planning as do any areas which involve the education of the young. Such planning and thought have not been neglected, and numerous scientific groups are giving this problem their serious attention. Among them are the National Research Council and the National Science Foundation, the American Institute of Biological Sciences and the National Society for Medical Research. Certainly American youth should not be deprived of the satisfaction and the benefits that come from the study of the living mammal because some people who do not know what they are talking about become overly vocal in their opposition.

This is not the time to hamper the teaching of biology. There is no doubt we are caught up in the forces of a great scientific revolution which has changed the lives of all us in the western world more in the last fifty years than in all previously recorded history. Furthermore, this scientific revolution has just begun, and if its early fruits do not destroy mankind in the immediate future, there is no predicting to what heights or depths it will ultimately lead him. Man is on the threshold of space; the peaceful use of atomic energy is in his grasp. In the biological fields we have just begun to feel the effects of the population explosion, a product in a large measure of medical research and its application to public health and preventive medicine. In all probability organ transplants are just around the corner if the immunological problems are solved as they probably will be, and the era of artificial organs is already upon us. New drugs will appear which will so alter and control man's physical and mental makeup that the mind shudders at the possible implications if their control falls into the improper hands. The biochemist is rapidly unravelling the structure of the chemical compounds responsible for the transmission of hereditary traits, and he may very well be on the threshold of protein synthesis and the creation of life itself. The ability to understand, let alone manage, these develop-

The American Biology Teacher

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ments will require a citizenry with a sound education in science and its techniques. Already the gulf between the scientist and the nonscientist is beginning to widen. C. P. Snow has eloquently called attention to the gap between these two groups and calls upon the western world to close this gap with all possible speed if it wishes to survive.[1] The duty of the biologist is clear; he must do all he can to broaden the understanding of his science among all elements of our population.

[1]Snow, C. P., *The Two Cultures and the Scientific Revolution*, Cambridge University Press, New York, 1959.

Code for Use of Animals in High School Biology Courses*

The first aim of demonstrations that involve animals in high school science courses is to achieve an understanding of life processes. Such studies lead to a sympathetic respect for life. A second aim of animal studies is to provide future citizens with some knowledge of the principles of health, disease, and medicine, and of some aspects of agriculture. In addition, by achieving these goals, some students are motivated to become the medical and biological scientists of the future.

Experiments which are useful for high school students are not necessarily the same as those which would be done in a university or medical school. Much can be learned about life processes from microorganisms and plants; invertebrates and cold-blooded vertebrates can be used for many animal studies in high schools, but birds and mammals are essential to the demonstration of certain concepts because of their closer similarities to man. The same guiding principle of respect for life in the use of animals for the welfare of man should apply in the study of all living objects, including the conservation of useful plants.

All observations on animals must be performed in a humane fashion and anesthetics used as appropriate for the kind of organism, the intactness of the animal, and the type of observation.

To guarantee that students acquire the spirit of humane treatment of animals, a qualified adult supervisor must assume primary responsibility for planning and conduct of demonstrations involving intact living animals. Such supervision must extend to both classroom and extracurricular projects.

Proper quarters and care must be provided at all times, including vacation periods. Students should be instructed in the principles of humane treatment of animals, and training in the proper handling of animals should be a part of the preparation of all high school biology teachers.

*These principles have been promulgated by a special committee with Professor Ladd Prosser, University of Illinois, as chairman. They have the full endorsement of the AIBS.

Survival in the Sea

Marine science, understanding how various forms of life adapt themselves to an underwater environment in the eternal struggle for survival, is the theme of the newest NET Film Service series, "*Survival in the Sea.*" The four 30-minute films are designed for use in high school and college biology classes and for general adult groups. Titles in the series are: *Where Land and Water Meet; On the Rocks; Life on the Coral Reef;* and *The Life Cycle.*

The series is available in either color or black and white from NET Film Service, Audio-Visual Center, Indiana University, Bloomington, Indiana. The purchase prices are $125 for black and white, and $250 for color prints.

The Green Drink

There once was an alga, Chlorella,
A Bostonian grew in his cella.
His brainy idear
Was to mix it with beer
To give to his Irish maid, Ella.

(In case you haven't noticed, a Bostonian is very apt to leave off a final "r" only to sneak it outlandishly onto the end of some unsuspecting word.)

John Brainerd

The Abuse of Animals in the Classroom and How It Can Be Avoided

Animal Welfare Institute, New York

Dr. Chauncey D. Leake, Professor of Pharmacology at Ohio State University, recently wrote: "It seems to me that it is wise to avoid getting our youngsters so enthused over biological sciences that they are anxious to undertake extensive animal experimentation without the background, the experience, the judgment, or the wisdom that is necessary in handling animals appropriately for complicated biological experimentation. In other words, I think we had better continue to learn the hard way: there is plenty of biology to be gotten from a study of unicellular organisms that can be readily obtained in any high school laboratory, and handled and followed with skill and convenience. We are apt to get into trouble using animals."

Sensationalism in the teaching of high school biology seems to us to be on the increase. No doubt the majority of our teachers avoid the practices listed below, but there are numerous cases of educators, possibly unable to convey the intellectual interest of their subject by more conscientious means, encouraging children to make cruel and pseudo-scientific experiments paralleling whatever field of research is receiving popular publicity at the time.

Following are examples of the type of painful and uncreative experimentation to which our organization is opposed. Pupils have been taught to "make routine transfer of cancer cells peritioneally in mice," and a machine has been devised to force mice to inhale high concentrations of tobacco smoke and pepper in connection with the national enquiry, "Does smoking cause lung cancer." Objections might also be raised to certain experiments by which "the effects of radiation on rats are determined," especially since the students concerned have not yet mastered the anatomy and physiology of the rats they are destroying. Again, at the height of the Sputnik publicity, children were taught to detonate home-made rockets containing mice, and here, while the making of the rocket may have familiarized the children with some principles of mechanics, the inclusion of the mouse, the thing that gave the project its glamor, had no sort of justification. As the *New York Herald Tribune* commented: "Let youngsters fire off tiny Sputniks if they can. But why imprison a mouse, or any living creature in one, if no knowledge is to be yielded by its death? Killing a mouse, suddenly, may be necessary to prudent housekeeping. Subjecting one needlessly to 3,284 feet of . . . terror shows little reverence for life. If increased interest in science is to lead merely to greater callousness, the world will not have moved ahead."

To criticize such misplaced attempts as the high school research projects described above is not to suggest that all animal life be excluded from the biology classroom. The judicious introduction of some forms of life can be a valuable teaching asset. Students will take a keener interest in the forms they are studying if they have an opportunity to observe them in life. They can be led to develop responsibility for animals kept in the classroom; prospective scientists must be made to realize that a normal healthy condition in the research animal is the *sine qua non* of an authentic biological experiment, and that it is a part of the scientist's job to see that his animals are well kept. All students may be trained to make careful and precise observations of the physical form and of the habit or movements of the species they are shown. The importance of a well developed technique of observation in biology can hardly be overestimated. Many important discoveries were not the result of hypothesis and experiment but were instead chance observations by trained observers. Sir Alexander Fleming's discovery of penicillin is a recent example. Interest, responsibility, and a technique of observation may be cultivated in students with the help of animal life kept in the classroom.[1] The major problem is the selection of suitable forms.

[1]Students may be interested to read some works on animal behavior by such distinguished observers as Tinbergen, Lorenz, Eckstein, von Frisch, Fabre, J. S. Harley, and others. The Animal Welfare Institute is preparing a pamphlet which will include a select bibliography of the writings on behavior most useful to the high school student.

Many teachers and scientists agree that some important principles of biology can be taught successfully with the help of live unicellular organisms such as protozoa, yeast, and bacteria. Colonies of ants, or, in rural areas, of bees, may be especially housed for class observation. The study of genetics is well illustrated by breeding the fruit-fly, *Drosophila*. Higher forms, such as reptiles, mammals, and birds, may be kept for general observation; however, the dissection of dead specimens, supplemented with models and filmstrips, should suffice to give the student a working knowledge of their anatomy and physiology. Crude experiments involving surgery or stress are not the training students need. Respect for living things, sound judgment, reliability, and a technique of observation will go further towards making competent biologists than will the kind of emotions aroused by crude surgery in supposed imitation of a fantasy hero.

Students who are induced to perform painful experiments on the higher animals should first be made aware of two points:

1. What they are doing is not advancing scientific knowledge or serving any altruistic purpose.
2. The enjoyment of tumor transplantation or other simple surgery is not an intellectual pleasure; the child who takes pleasure in such practices is likely to be indulging the darkest and most destructive side of his personality.

Teachers and students alike ought to give careful thought to these two points so as to be in a position to take moral responsibility for their acts if there is anything hazy in their realization of the above two points.

If animals are to be kept in the classroom, it is of the first importance that the teacher should enforce a serious and knowledgeable attitude toward their care. Most students will be interested in constructing and outfitting suitable quarters for classroom animals; some will be willing to undertake care and feeding. It is essential that the routine of cleaning, watering, and feeding be inflexibly carried out. Some teachers have found that the best method is to assign two volunteers to each cage of animals for an entire semester. The daily ration of food and water for each cage and the routine days for cleaning should be posted, so that in case of absence substitutes will know where to take over. Sudden changes in diet may cause colic and intestinal disturbances. *Care must be taken that a triple ration of food and water is always provided on Fridays.* Vacation periods present a major problem: *in our experience, school janitors are never reliable animal caretakers.* It will probably be necessary for the animals to board with the teacher or with a really responsible student. The teacher who decides to keep animals in the classroom must take the ultimate responsibility for the care and feeding of the animals at all times.

Two indispensible pieces of equipment for keeping rodents are the water bottle and the food hopper. The hopper prevents animals from scattering and wasting their food; the water bottle ensures that the drinking supply will not be spilt and the animals left thirsty during an unsupervised period. A water bottle is simple to make. Through the cork of the bottle goes a piece of glass tubing with an internal diameter of 3/8", and thick walls. The outer end of the tube has been rotated in a Bunsen flame until the opening is between 1/16" and 1/8" in diameter and bent at an angle of not more than 45° out of straight, so that, when the bottle is hung inverted in the cage, the spout curves downwards and outwards. If the cork is airtight, the water will not run out when the bottle is filled but will always be available at the tip of the tube. The table gives measurements for some common laboratory animals:

	Mouse	*Rat*	*Guinea Pig*	*Rabbit*
Capacity of bottle	4 oz.	1 pt.	1 pt.	1 pt. (for 1 rabbit)
Distance of spout from cage floor for adults:	1½"	6"	4"	6"
for young	same	3"	2"	3"

All caged animals require fresh water at all times, and food should also be available to them on a twenty-four hour basis.

If the cages are placed in an area receiving direct sunlight at any time of day, a sunshade must be provided by attaching brown paper to the sides and top of about one-third of the cage area. Animals must never be left in a draft, but adequate provision for ventilation must be made, especially over the weekend.

It is also the teacher's responsibility to kill diseased or unwanted animals by a humane

method. The best killing method is the chloroform chamber. A chloroform chamber is a box containing a wire netting shelf raised above the floor level, with a perforated lid. A piece of cotton wool saturated with chloroform is placed on the floor of the box, and the animal is placed on the wire netting shelf above. The animal must never come into direct contact with liquid chloroform which irritates the mucous membranes. Since the object is to anesthetize, not to asphyxiate, an adequate amount of outside air must enter the box until the animal is unconscious. The animal may be observed through a hole in the lid; if it struggles, more air should be admitted; when it becomes unconscious, all outside air should be cut off. Never remove the animal from the chloroform box or dispose of the body until it is stiff and cold.

Mice, rats, guinea pigs, rabbits, frogs, and fish are some of the animals most likely to be kept in the classroom. *The teacher should familiarize all students with the basic requirements of the chosen species and demonstrate the correct method of handling it.* Some notes on the basic care and handling of the common species follow: These notes outline minimum standards; students may be encouraged to raise these standards further. For example, they may wish to design roomier cages with more elaborate exercise facilities or nest boxes than are described below; experimenting in obtaining the optimum housing arrangement or diet will train students to make close observations of the animals' condition.

Mice: Four mice or a breeding pair may be kept in a cage 6″ x 12″, but a larger cage will provide more space for activity and more opportunity for interesting observations. Mice can be kept in a wire mesh cage with a wire mesh floor and a movable tray beneath, which should be lined with newspaper and cleaned daily. However, recent scientific studies show that a solid nonporous cage floor, covered with peat moss or shavings, provides an optimum environment for mice, and that mice thus housed are healthier and more content than mice kept on wire mesh. The whole cage should be washed in soap and hot water weekly. If there is a possibility of infection, disinfectant should be added to the water. The cage *must* be thoroughly dried before the mice are replaced. Mice are sensitive to sudden changes of temperature and thrive at temperatures of 68°-72°. Suckling mice require a temperature of 76°-78°. Mice are by nature nocturnal and should be provided with a dark corner in the form of a nesting box. It should contain bedding material such as shredded paper, woodshavings, or cotton wool. A convenient nesting box is a small metal cup, inverted, with an entrance cut in one side at the rim. An exercise device such as a Ferris wheel is a good idea. Mice are omnivorous and will thrive on a diet of meat, fish, cheese and vegetable scraps, supplemented with bread, oats, sunflower seed, hemp, or millet. It is also possible to feed them on a diet of commercial mouse pellets if these are supplemented with greens, yeast, and any of the above mentioned foods. An exclusive diet of commercial mouse pellets may result in malnutrition and cannibalism. Mice are usually docile; a mouse may be picked up by placing the fingers under the animal and gently easing it into the palm of the hand. Mice may also be lifted, not carried, by the base of the tail if excitable. Gentle stroking may help to calm them.

Rats: A rat cage should be similar in design to a mouse cage but considerably larger. Seven hundred square inches of floor space is the recommended minimum for eight rats. Rats require a nesting box. Cleaning the rat cage is an identical operation to cleaning the mouse cage. Rats are susceptible to respiratory diseases, and a constant temperature of 65°-70°F., low humidity, and good ventilation are essential to good health. Rats may be fed on a diet of commercial rat pellets, supplemented with grain, greens, milk, meat, fish, and vegetables. While rats are intelligent and make excellent pets, an angry or frightened rat will inflict a painful bite. It is advisable to handle rats gently, to avoid sudden movements, and to give the rat time to realize it is going to be handled before picking it up. The best way to pick up a rat is to place the hand palm down over the animal's back, with the thumb and forefinger around the neck, and the remaining fingers around the animal's body to take the weight. Rats are playful and appreciate exercise facilities such as Ferris wheels. Nonbreeding rats and mice should be separated from breeding specimens.

Guinea pigs: Guinea pigs may be kept in pens whose floors are covered in a 2″ layer of sawdust or peat moss followed by a layer of straw. An adult guinea pig requires one square foot or

floor space but will exercise better in a larger area. If guinea pigs are kept in wire mesh bottom cages, the mesh must be ⅜", otherwise the animals will suffer leg injuries. In a wire mesh cage bedding material such as peat moss or softwood sawdust must be provided. Guinea pigs may be fed on hay, which must be kept in a rack to prevent soiling, commercial guinea pig pellets, and fresh greens. If a liberal supply of grass, clover, alfalfa, cabbage, kale, chicory, lettuce, or sprouted grain is not given, guinea pigs develop a Vitamin C deficiency which is often fatal. Guinea pigs thrive in a cool, dry climate, 65°-79°F. They should be handled gently, avoiding pressure on the abdomen. Pregnant females should not be handled. To pick up a guinea pig, place one hand well up across the shoulders, with the thumb behind a front leg, and the fingers well forward on the opposite side. Work fingers gently under the hindquarters to take the weight.

Rabbits: Rabbits require a roomy cage. One square foot of floor space for every pound of rabbit is a general rule. Rabbits rest extended with their feet stretched out behind them, and any cage which prevents them from doing this should be allocated to a smaller species. The cage floor should be covered with 2" of softwood sawdust or peat moss. Rabbits prefer a cool temperature, 60°-65°F. Strong drafts or strong sunlight are to be avoided. Rabbits may be fed on commercial rabbit pellets or on a grain mixture of whole oats, wheat, and barley. They also require a good quantity of alfalfa or clover hay, and green, and root vegetables daily. If rabbits are put out to grass, or given an excessive quantity of green food, they should first be given a meal of grain or pellets, to prevent them from taking a surfeit of green food and developing colic. Never lift a rabbit by the ears without supporting its hindquarters with the other hand. It may be preferable to grasp the rabbit by the scruff of the neck while supporting the hindquarters as above. Rabbits are inclined to jump and kick when lifted; they must be treated gently but firmly. Rabbits not gently handled may scratch. Adult rabbits should be housed singly, as they often fight.

Amphibians: Frogs may be kept in large tanks or concrete pools. It is essential to provide a resting place outside of the water in the form of a raft or raised plank. The top of the enclosure must be screened to prevent escape. The water must be changed daily, unless a system of running water is used. Frogs kept in foul water die. A diet of maggots, mealworms, slugs, earthworms, blowfly larvae, or meat is suitable and should be placed out of the water. Methods of raising these larvae and worms are described in the Animal Welfare Institute publication, "First Aid and Care of Small Animals," by Ernest P. Walker. Toads should have a similar diet. They thrive in a large cage whose floor is covered with moist earth or gravel. A rockery of stones or bricks, under which the toads can retire, is recommended. Frogs and toads may be killed in a chloroform chamber.

Fish: An aquarium may be planted with pondweed which will increase the oxygen content of the water and stocked with a few snails which feed on decaying vegetable matter and help to keep the aquarium clean. Further cleaning may be carried out with a siphon. Sudden changes in water or water temperature are harmful to fish, and all the water in an aquarium should never be changed at once. Chlorine is harmful to fish, and tap water is to be avoided if pondwater is available. If tap water must be used, it should stand in shallow pans for several days before use. When water weed will grow in water, it is generally safe for fish. It is essential that the aquarium should contain adequate water and water surface. One gallon of water per inch of fish is a general rule. For six one-inch fish, an aquarium 16" x 9" x 9" is adequate. This provides 5 gallons of water and 144 square inches of air surface. Overfeeding and overcrowding are the most frequent causes of death to aquarium fish, according to the New York Aquarium. Goldfish may be fed chopped raw meat, or angleworms, and a good quality of commercial fish food. In feeding tropical fish it is especially important to provide a variety of different foods so the fish can select what they prefer, because the dietary needs of the different species are not well established. Tropical fish aquaria should be maintained at a constant temperature of 75°F., and a cover provided to prevent the fish from jumping out. In order to avoid overfeeding, remove any uneaten food ten minutes after the fish have been offered it.

The Animal Welfare Institute would be glad to furnish a list of books and pamphlets

relating to animal care and teaching with animals in schools. Especially recommended are the pamphlet, "First Aid and Care of Small Animals," free on request by a teacher; an English publication, "Animals in Schools," by J. P. Volrath of the Universities Federation for Animal Welfare; and "Humane Biology Projects," now available from the Animal Welfare Institute. Address enquiries to: The Animal Welfare Institute, 22 East 17th Street, New York 3, New York.

Some Feeding Problems Solved

SISTER MARY ADELAIDE, *Marian College, Indianapolis, Indiana*

The value of living animals in the laboratory is recognized by every biology teacher who possesses the true professional spirit. If these animals are to be kept over a considerable period of time the problem of providing food for them is not always easy, especially in the case of the very common laboratory animal, the frog.

We are all aware of the fact that, in order to attract the attention of frogs, food must be moving; that insects on the wing, therefore, form their natural diet. When flying and hopping insects are no longer available out of doors, one must look for suitable substitutes.

Earthworms make an excellent substitute for insects. These can be easily collected in the fall long after grasshoppers are no longer available and in the spring before the insect world is astir. A mass of squirming earthworms on the drained floor of a frog tank or a few dropped onto a white sheet of paper never fail to attract the attention of the occupants. They may not dispatch a worm with the same speed as they do a butterfly or a grasshopper, but they do so nonetheless effectively. An interesting tug of war may develop when the attention of one frog is caught by a large dangling worm, half-swallowed by another frog. You may be impelled to end the struggle by snipping the worm in two.

Other creeping and crawling creatures such as slugs, centipedes, pill bugs, even ants, make satisfactory food for frogs. They are quick to sense the presence of food that is accompanied by even the slightest movement. It is safe to say that any visible, motile object, no matter how small, yet not too large, may be captured and relished by a hungry frog.

During a prolonged winter season it may be impossible to obtain any living food for laboratory animals. At such times one must resort to force-feeding of frogs, if they are to be kept in a vigorous, healthy condition. With a little practice this apparently impossible task can be quickly performed. Two pairs of forceps, two pairs of hands, and pieces of meat of almost any kind are all that is necessary. The upper jaw can be forced open with one pair of forceps while the lower jaw is grasped with the other pair. Once the jaws have been separated, they can be kept so with one pair of forceps while the food is dropped into the mouth between the open prongs. It will be necessary to force the food back into the pharynx. This can be done with the handle of a teasing needle or any similar blunt object. Once the food has reached the pharynx the frog will swallow automatically. One can even note the animal's preference for certain foods, for example hamburger, which he swallows with avidity. This is most easily served in a frozen condition. If there is a refrigerator in the laboratory, keeping a supply of food on hand for this purpose is simple since one can store the remains of a freshly dissected animal or the flesh of an animal, such as a squirrel, accidentally killed by a passing auto. The force-feeding of a large number of frogs may seem tedious and time-consuming for a busy teacher, but it is a task which elementary school boys will gladly perform for the college teacher who is fortunate enough to have youngsters from the neighborhood making occasional visits to the laboratory.

However, force-feeding need never be resorted to if one keeps on hand a culture of the meal worm, *Tenebrio*. The larvae of these

beetles, now commonly used as fish bait and bird food, make excellent food for frogs, as does the adult beetle. Cultures can easily and economically be kept in the laboratory all year round.

Snakes are interesting animals and can serve useful instructional purposes in biology classes but feeding them also poses a problem for the inexperienced. When first deprived of outdoor freedom they usually sulk and refuse to eat. Frogs and mice placed in their cage remain untouched. If they persist in this hunger strike for months, or if suitable food is not available, one must resort to force-feeding if they are not to starve to death. This can be done in the manner described for the feeding of frogs.

A large pilot blacksnake after six months of captivity and force-feeding began to feed freely on frogs and mice placed in its cage. It is not necessary that these animals be alive, at least in dealing with some snakes. This is most convenient since a mouse caught in a trap provides the snake with a most acceptable meal. It should be noted, however, that such mice should not be "too dead." A snake has a keen sense of smell and will not touch decaying flesh. An excess supply of dead mice at any one time can be frozen and used later.

A bat can be of service to the biology teacher and can be kept alive for a long time indoors if food is supplied. Fruit juices can be fed with a pipette or fruit can be dropped into the mouth. Grasp the animal by the nape of the neck with one hand protected by cloth or glove and with the other pipette the juice, or even sugar water, into the mouth or drop small pieces of grape or apple. As the bat invariably opens its mouth and squeaks when held in the manner suggested the need of force-feeding as with frogs and snakes is eliminated. Most bats will swallow food that pleases them once it is in the buccal cavity. Forcing it into the pharynx or esophagus is not necessary.

A shrew is an interesting object of observation in a biology laboratory because shrews are quite uncommon, and for most students, the novelty of making their acquaintance and observing their incessant activity is a lesson in itself. A shrew requires a tremendous amount of food for its size but fortunately is both vegetarian and carnivorous and never requires force-feeding. A study of all the varieties of food consumed by this little creature would make an interesting project. They are fond of corn and other cereal grains, of earthworms and slugs. Placed in a terrarium with frogs and salamanders a shrew will readily dispose of several in a few days, leaving not even a trace of a bone. The utter confusion resulting from trying to house a shrew with such peaceloving animals as amphibians makes the observer realize the impossibility of "taming the shrew."

Motivation for the above suggestions on feeding of laboratory animals was provided by Harold Kaplan's very practical article "Diseases in Laboratory Frogs and Turtles" which appeared in the May, 1958, issue of the ABT, in which Mr. Kaplan, in a paragraph on the feeding of frogs makes the point that "feeding frogs is laborious." These few notes may be helpful to fellow biology teachers and relieve somewhat the labor involved in feeding, especially the frog.

Additional Reports on Experimentation

Other reports which might be of interest to those teachers interested in animal experimentation are:

"Animal Experimentation in Secondary Schools," *The Bulletin for Medical Research*, January-February, 1960, Vol. 14, No. 1, pp. 16-19. This is published by the National Society for Medical Research, 920 South Michigan Boulevard, Chicago 5, Illinois. Ralph A. Rohweder is Executive Secretary.

"Animal Experimentation by Secondary School Students," *Report on the National Conference on the Legal Environment of Medical Science*, May 27-28, 1959, National Society for Medical Research and the University of Chicago, pp. 55-58.

"A Symposium on Laboratory Animals: Their Care and Their Facilities," *The Journal of Medical Education*, January, 1960, Vol. 35, No. 1, 55 pp.

Proceedings of the Animal Care Panel, March, 1960, Vol. 10, No. 1, Animal Care Panel, Inc., Box 299, Lemont, Illinois.

A Solution to the Live Animal Problem in High School

MARY G. GIBBON
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One of the most distressing problems for a high school biology teacher is the one which confronts her every spring—that of "farming out" or disposing of live animals which have accumulated over the school year. The problem became especially acute this year since we are now the proud possessors of a modern suite of classrooms with their accompanying "small animals" room. We acquired some white rats and one hooded rat who was promptly adopted by all. He was so loveable that he was handled by many. He fathered several litters of hybrid hooded and albino rats. Offers of rats as gifts were politely refused; pet shops declined them, and out of all the population I possessed, I managed to farm out four of them and gave away six for breeding purposes. I was desperate when a chance remark by one of my colleagues set me thinking, and I came up with a solution which, I hope, will be of some help to any other poor soul who is suffering with the problem of disposing of rats.

A former student, who is studying mortuary science, stopped by to visit one day, so I asked him to teach me and some of my boys to embalm rats. He was agreeable, and so we selected three boys who were willing; together we all learned what to do. We tried the arterial method, usually used on humans, but found the artery of the rat is too small to be used; then we used the cavity method of enbalming, which is usually used on small children. The embalming fluid is the type used for cavity work. Arterial fluid can be used, but it is more expensive. Our embalming fluid has all been donated by local morticians. It is diluted as per the directions on the bottle.

First we selected a rat, placed it in a plastic bag and applied tap gas to the open end. We found this to be a painless method of killing the rats, and by far, the cheapest. We tried ether and chloroform and did not find it any better than natural gas. The animal just goes to sleep, and that is all there is to it. After we are sure of death and the heart has stopped, the animal is laid on its back with the legs spread out, and the injection of the embalming fluid begins. We use a 10 cc. syringe and an intramuscular needle. Injections of fluid are made into the heart, lungs, and abdominal cavity. It is especially important that the abdominal cavity be done thoroughly because here is where putrefaction sets in. For this reason plenty of fluid is pumped in from six different places. If the animal is a male, inject the scrotum in several places, then the tail. The animal is then turned over and the back is injected in several places so as to reach the muscles. Each leg is injected in both directions so that the fluid gets into the feet as well as into the upper part of the leg. Next, inject the neck, then turn the animal on its side and the brain through each ear. Now the embalming process is completed. The animal is placed in a jar of formaldehyde ready for dissection at a future date.

The boys who were the first to do this work have taught their successors, and we are now ready for the third generation of "teen-age morticians," as they call themselves. We dissected the rats last year and found them to be in an excellent state of preservation. In addition, I found the students very interested in this dissection since it is a mammal. They kept repeating to one another as well as to me such phrases as, "This is what I look like inside"; "Is my diaphragm as tough as this one?" "Do we really have as much intestine, proportionally, as this rat?"

We also discovered that we had killed two pregnant rats, which were a tremendous source of interest.

The project did not cost much except in time, but it was really worth it. We have more rats for this year's class to dissect. I can recommend this school project as a worthwhile teaching device and an acceptable method of solving the ever-increasing school rat population.

Biological Program of Spaceship*

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Union of Soviet Socialist Republics

The science of the laws of life which up to now embraced our planet only has currently acquired new perspective. Cosmic biology has made its appearance and is successfully developing. Every observation of the test animals on the spaceship, every observation of the rhythm of their vital functions and digressions from normal during the period of launching, as well as its subsequent restoration, is of unmatched significance for physiology, biochemistry, and medicine.

The orbiting of a spaceship carrying numerous instruments and living organisms around the Earth, the possibility of carrying out TV observation of the state of the animals during flight and, finally, the flawlessly executed return of the spaceship, instruments, and living organisms to the Earth mark an important stage in preparations for a future manned flight into space. However, for such a flight to be possible many problems must be solved and very complicated ones at that.

The first of these is the creation of a powerful carrier rocket with a high-precision system of control that would insure that the spaceship keep strictly to its plotted orbit and return to a predetermined area on Earth. We have already witnessed how successfully this problem was solved by Soviet scientists and designers.

The second problem is elaborating the techniques of returning the vehicle and space traveller to the Earth. The successful flight of the second satellite-spaceship has shown that this problem too is being solved by Soviet scientists. If a manned flight into space depended only on the successful solution of these first two problems, we might say with certainty that this flight was literally a matter of the most immediate future. But in order for such a flight to be materialized another very complicated problem must be solved—a normal biological environment must be created for man during his flight.

The conditions which man will meet in a flight into space are already known in many respects. These include unaccustomed acceleration, weightlessness, low pressures, vibrations, unusual composition of the surrounding environment, influence of penetrating radiation carrying high-energy particles, unusual view of the world around where, for instance, the sky will be black, and other conditions of the cosmic environment differing from those in men's environment on the Earth.

Much of this can be studied and foreseen to prepare the future space traveller for this unaccustomed environment. But it is one thing studying these conditions with the help of instruments on rockets and satellites and testing the influence of these conditions on man on Earth. It is an entirely different thing to be convinced first hand or to prove experimentally that all computations were correct, that everything required for the normal vital functions of the human organism in conditions of space flight had been taken into consideration and provided for. In this respect an invaluable service is being rendered to man by the space pioneers, that is, the dogs which he sends on flights into outer space. Observations of other animals that have been in outer space also provide valuable material.

Man's invariable companion in future flights and, in particular, in landings on other planets must be green vegetation. On the Earth this is not only part of a customary and pleasant environment—it is absolutely essential for man. These plants create organic substances which serve as food for man and animals, they cleanse the air of carbon dioxide, the product of their respiration, and generate oxygen in the process of photosynthesis. This job is done by land and the tiniest water plants.

The higher plants provide man with valuable and diverse products and materials. But they possess a sharply defined cycle of vital processes. Unicellular water plants cultivated in artificial nutrient media remain regularly active in growth and photosynthesis over a long period of time. They produce organic

*This article is being published because it might be of interest to our readers anxious to know more about Soviet work in this area. It originally appeared in *Pravda*, August 25, 1960.

substances, cleanse the air of carbon dioxide, and enrich it with oxygen.

All this determined the manifold and profoundly elaborated content of the biological program carried out on board the spaceship. The main tasks of these biological experiments were: to study the peculiarities of vital functions of various animal and vegetable organisms in conditions of cosmic flight; to do research regarding the biological effect on living organisms of the basic factors in space travel, long periods of overstrain, weightlessness, transition from sub-to super-weight, and vice versa; to study the effect of cosmic radiation on animal and vegetable organisms, that is, on the state of their vital activities and heredity; to make a study of the effectiveness and features governing the functioning of the systems ensuring vital activities in flight, for example, the systems of regeneration, thermoregulation, feeding and water supply, waste disposal, and others; to study the effectiveness and reliability of operation of the descent and landing systems of the spaceship's cabin with containers for biological objects.

The passengers taken along included the simplest modern living organisms such as bacteriophages or bacteria parasites, various microorganisms, intestinal bacilli, butyric acid fermentation bacteria, staphylococci, fungi cultures, actinomycetes, and unicellular green plants. The representatives of the higher plants included spiderworts in bloom, seeds of maize, and of various varieties of wheat, peas, and *Nigella*. There were also insects—*Drosophila*, and cancerous cells of man. This wide range of different biological objects varying in level of organization and in demands to environment conditions will undoubtedly help to settle questions concerning "biologically transferrable" elements of the environment in cosmic flights.

Cancerous cells found in man have been cultivated for many years in glass jars independent of the human organism. Their behavior in conditions of space flight will enable us to judge to a certain extent the effect of specific conditions created in cosmic flight on human cells and tissues. In the future, it will obviously be possible to carry out research with normal human cells which have also been long cultivated independent of the human organism. Among the biological objects belonging to this category that were placed in the container of the spaceship were conserved segments of tissue, skin, of man and rabbit.

Some of the bacteria which underwent this cosmic experiment are the constant companions of man and animals. They usually live on the surface of the body (staphylococci) or else in the intestines (intestinal bacilla of various types). It is very important to know how these companions of the human organism react to the unusual conditions of cosmic flight: whether their activity lowers or heightens, etc. This might have direct bearing on the health of the space traveller.

At the same time microorganisms, bacteria and fungi, are very convenient and comparatively simple biological models on which to study the general laws of how the environment and conditions of existence influence elementary vital processes. They are particularly useful in studying the influence of outer factors, for instance, radiation, on heredity. Thanks to the high speed at which they multiply and at which generations succeed each other, it is easy to reckon the results of various physical and chemical influences.

Among the "passengers" of the spaceship we see representatives of bacteria more sensitive to radiation, as the intestinal bacilli "KK-12," and highly stable bacteria, intestinal bacilli "V." Of particular interest are the fungi, actinomycetes, many of which are used to make antibiotics.

There can be no doubt. Ascertaining the influence of space flight conditions on these animal and vegetable organisms is of great significance.

The ship also had some mammals on board, white and black mice and rats in addition to the dogs, Strelka and Belka. According to the dogs' behavior during flight they can be divided with sufficient clarity into types of higher nervous activity. Strelka is the calm, strong, and even-tempered type as contrasted to the more irritable, reactive, and mobile Belka. The difference in types of higher nervous activity provides a convenient case for determining the particulars of these animals' state or conduct under the influence of different factors of the flight. This circumstance is of great scientific interest.

Of tremendous significance for a future

manned flight is the possibility of rapid biological regeneration of the atmosphere inside the hermetically sealed cabin, the possibility of enriching it with oxygen making use of the products of man's vital activities. This entails creating artificially conditions in a closed sector of space that would, on the one hand, place the space traveler into conditions that he is used to in life on Earth and, on the other hand, solve the complicated problem of providing him with everything required for normal existence during a prolonged flight.

To solve this problem, unicellular microscopic green algae, *Chlorella*, was placed in the container. This will obviously be a valuable companion of space travelers on long flights since it is capable of supplying oxygen for the air in the cabin. It is very important to ascertain how these so-called oxygen factories will behave in conditions of space flight.

In the past decade the all-round study of *Chlorella* has assumed great scientific and practical interest, not only in connection with its possible use in cosmic flights, but as a potential source of full-value nutrition attainable in unlimited quantities over enormous areas of water on our planet.

A manned flight into outer space entails thorough and diverse preparations. It cannot be dictated by mere publicity or similar considerations. Therefore, the program of biological research foresees settling the entire complex of questions directly connected with ensuring normal working ability, vital activity, and absolute safety of man's flight into the Universe. In this connection the attention paid to genetic research is fully justified. The phages, microorganisms, higher plants, insects, tissue cultures, mice and rats, that made this trip into space have long been classical objects for this research. The experiment carried out in space will not only make it possible to ascertain the biological action of certain flight-factors to a greater extent but will determine their possible influence on future generations.

It goes without saying that it is still impossible at present to make final conclusions. The data acquired must be thoroughly studied and analyzed. At the same time the fact that all these representatives of the organic world retained their vital function and returned safely to the earth is in itself an outstanding achievement. There can be no doubt that we now have all grounds for saying in all certainty that man's age-old dream of flights into outer space is close to being materialized. Tremendous prospects will unfold not only for studying the laws governing life on Earth out in cosmic space but for settling the question of whether life on other planets exists and in what forms.

New Anti-Serum Destroys Sympathetic Nervous System

A substance which may have clinical value in dealing with ailments stemming from the tensions of modern life has been discovered by zoologists at Washington University, St. Louis. The substance, an anti-serum, selectively destroys the sympathetic nervous system when injected into animals without otherwise interfering with their vitality.

Two scientists, Dr. Rita Levi-Montalcini, professor of zoology at Washington University, and Stanley Cohen, former associate professor now at Vanderbilt University, were major figures in the work.

The sympathetic nervous system has a role in regulating blood pressure, and it indirectly controls the biological source of certain emotional states. Since many human ailments can be traced to excessive activity of the sympathetic nervous system, there has been considerable interest in finding ways of cutting down its activity.

Drs. Levi-Montalcini and Cohen obtained the anti-serum by injecting purified extract of mouse salivary glands into rabbits. Previously, the scientists had learned that mouse salivary glands, snake venom and a certain type of cancerous tumor occurring in mice contained an agent that caused abnormal growth of sympathetic nerve fibers.

"When we injected the anti-serum from the rabbits into new-born mice," Dr. Levi-Montalcini said, "we got an almost complete disappearance of the sympathetic nervous system."

After this, the material was tried on rats, rabbits, kittens, and a squirrel monkey, with the results being a 90 to 99 per cent disappearance of the sympathetic nervous system in a few days. Another interesting aspect of the research is the indication that an agent essential to the growth and maintenance of the sympathetc nervous system is normally present in the blood.

Building Animal Cages and Containers For Classroom Use*

PAUL W. WELLIVER
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Oak Ridge, Tennessee

Biology teaching is coming alive. All over the country the leading educators in life sciences are urging that more living specimens be introduced into the biology teaching program. The response among teachers has been good, and gradually the odor of formaldehyde which once permeated and dominated the high school biology classroom is being overcome by the educationally more desirable odor of living things. At last the biology room is a living room, and high school biology is truly becoming a study of living things.

With the introduction of more and more animals into the classroom, many difficulties present themselves. The teacher is confronted with the problem of housing, feeding, and caring for these animals. To overcome these difficulties one must possess proper equipment, have the necessary know-how, and organize efficient student help. However, the question which is probably most often asked when the problem of keeping animals arises is, "Where am I going to put them?"

The answer to this question lies in your basement, in your attic, in the storage rooms at the school, and, yes, even on the junk piles. One need only to utilize the materials which he finds in these places in order to devise suitable containers in which to keep the animals which he wants. Not knowing exactly what you may find when you explore these regions of your home and school, I am unable to tell you what to build and how to build it. However, my purpose is not to answer these questions for you but rather to help you to best answer them for yourself.

What then should you do when you find yourself asking the question, "Where am I going to put them?" It is up to you to design a cage from the materials which you have available. But before you begin sawing, hammering, and bolting things together, the following factors should be given careful consideration.

Does the cage sufficiently resemble the natural habitat of the animal to provide comfort and insure longer life?

Does the construction of the cage make it possible to feed and water the animals easily and make regular thorough cleaning possible with a minimum of effort?

Are you using good, and yet inexpensive, materials in the construction?

Is the cage being constructed in the best way possible to fit into the space which you have for it in the room in which you teach?

Is your work neat? There seems to be a feeling among many who use home-made equipment in their teaching that an effort

*Given at the NABT meeting with the AIBS at Pennsylvania State University, August, 1959.

should be made to insure that it appears homemade. This I believe to be a mistake. Neatness is among the most important lessons which our students must learn, and whenever a good example can be set, I feel that it should be done. If a coat of paint would help to enhance the finished product, then by all means apply it.

So far we have said nothing about getting ideas for the types of cages one could build.

Using the idea employed in the cage on the left front, new cages were developed using the same general plan but different materials.

A garbage can—used to house an opossum.

The most valuable source of these ideas lies in your own imagination, and there are several methods for stimulating creative thoughts.

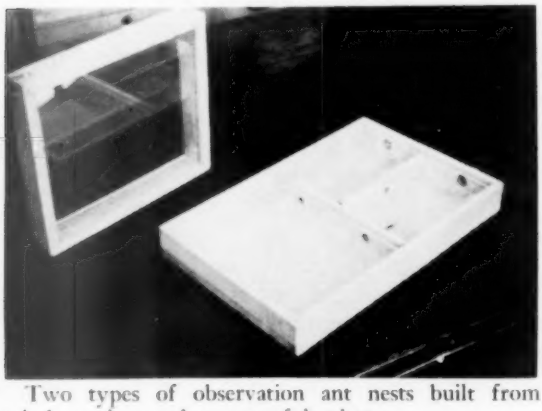
As a biology teacher you are probably flooded with advertisements from science supply companies picturing and describing equipment which will meet this need. Study these advertisements carefully. Is it possible that with materials which you have available,

A multipurpose cage constructed from barrel lids and hardware cloth.

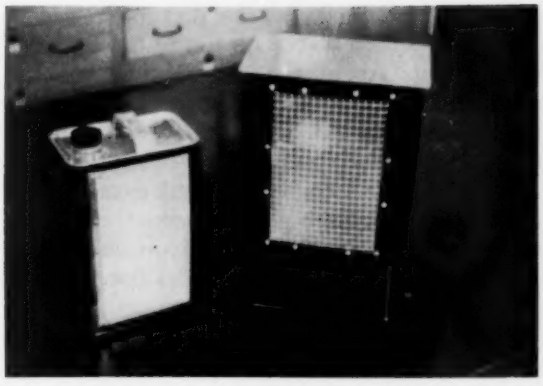
An inexpensive cage for rats, mice and hamsters made from cake pans and hardware cloth.

you could build something which will perform the same function and possibly do it better?

The vertical and horizontal observation ant nests which most biological supply companies have available can easily be constructed using scraps of lumber and pieces of window glass. Rat, mouse, and hamster cages can be assembled using hardware cloth, strips of



Two types of observation ant nests built from window glass and scraps of lumber.



Using oil cans to construct a cage for insects and a cage for small mammals.

metal, aluminum baking pans, or whatever suitable materials you may have available. Look at the other advertisements. What do you have which could be used to build a cage of that type?

Often when you need a cage for a new animal, you can devise a design based on another cage which you have used previously and which has proved its usefulness. To illustrate this, let us look at an example of how such a development actually took place. The cage from which the other ideas evolved is a home-made cage familiar to many biology teachers. It can be constructed simply by forming a cylinder of hardware cloth and fitting an aluminum cake pan on the top and bottom. A floor may then be made by wiring a disc of hardware cloth into the cylinder about an inch above the bottom. Such a cage is very effective for keeping small laboratory animals.

One day a student brought in some insects. Window screening was substituted for hardware cloth and the insects were housed.

When the rats began to have litters, again the original cages proved to be inadequate; this time because they were too small. In a search for something to build a larger cage, two twenty-inch diameter metal barrel lids offered the solution. Substituting the barrel lids for the cake pans and making a larger hardware cloth cylinder to fit them, the new problem was solved.

When an opossum was brought to school the need for a proper cage was renewed. This time a garbage can was utilized. The can itself served as the base. A cylinder made of lawn fencing was slipped over the top of the

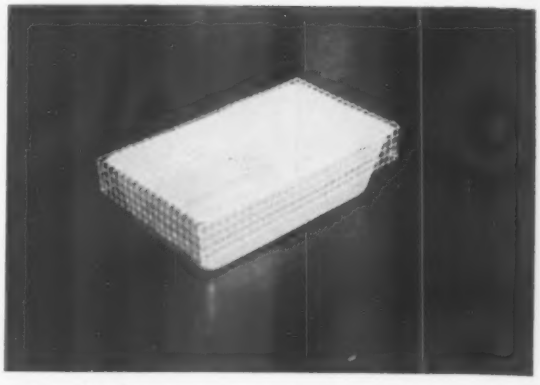
can and rested on the handles of the can. The lid was then placed on top of the cylinder of fencing. Again the general idea of the original cage was used, but it was adapted to the new situation. To complete the interior, a platform was placed at about the level of the top of the can, and a stick attached to the platform hanging down into the can so that the opossum could climb up and down as it wished. New ideas had developed from a familiar method.

Another way to gain inspiration is to look at materials around you while constantly asking the question, "What kind of a cage could I make out of that?" You would be amazed at the number of times a good answer presents itself. Ten-quart oil cans may be converted into homes for many types of animals. Jars can be used for many purposes.

Suppose, for example, you do not have sufficient aquarium space for the fish and other water animals that you wish to keep. A gallon jug with the top cut off can be used for a small aquarium. The top can be removed by passing an electric current through a nichrome wire wrapped around the jar at the level where the break is desired. If the break does not take place by just heating in this manner, remove the wire from the jar and run cold water over the place where heat was applied. If done properly, the jar will be cut with an even, level rim. The nichrome wire can be replaced by a piece of string soaked in alcohol and burned while surrounding the jar. This is perhaps a more convenient but less effective method.

Realizing that it is not essential to look through the sides of an aquarium, one can find many substitutes for the standard aquaria which are excellent for keeping fish and such animals as turtles, frogs, crayfish, snakes, etc. Dishpans, washtubs, all sorts of plastic containers which can be found in the stores, and even an old bathtub are all ideal. By setting up the proper environment in the containers mentioned, or in any other container which you may have available, excellent substitutes for expensive aquariums can be devised. Incidentally, the reference to the use of a bathtub was not made in jest. Bathtubs have been used with much success in the classroom for keeping this type of animal.

Some plastic containers obtained at a variety store which would be useful for keeping living things.



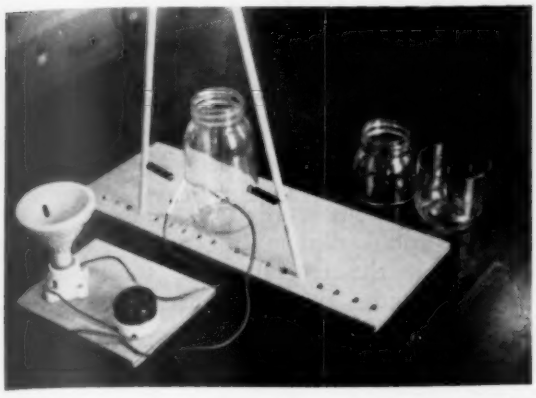
An aluminum pan and hardware cloth make a home for mice.

These are only a few examples of things you have around you every day which would be useful for keeping animals. Keep looking. There are lots of possibilities.

Current science education journals as well as books and pamphlets on science teaching methods will provide you with helpful suggestions. Adapt these suggestions to your own needs and situation. Information ranges from very simple methods of keeping animals in jars to detailed plans for constructing more elegant devices. For example, a long time desire for an observation beehive was fulfilled after a search of the literature which revealed plans for building one.[1]

What I have tried to present is not a list of cages which I feel that every biology teacher should make. Rather, I have attempted to give some suggestions as to how to develop ideas which will best make use of the resources

[1]Shaw, F. R., "Observation Beehives: Construction —Use," *Gleanings in Bee Culture*, November, 1952, Vol. 80, No. 11, pp. 656-658.



Using a hot wire to cut glass and produce useful containers.

which you have in order to fulfill your own needs. The number of examples which I have given has been small but the possibilities are numberless.

It is important that the biology classroom in your school be a living biology room. The next time that the appearance of an animal prompts the question, "Where shall I put it?" spend a few moments in your attic, in your basement, in a hardware store, or just staring at a pile of junk. The answer is sure to be there.

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Heredity by TV

An educational television series called "Heredity," produced by the KUHT Film Production Department, had its national premiere the week of July 17. The series began in San Francisco, Boston, Chicago, Pittsburgh, and New Orleans, as well as Houston. The program will be seen at later dates in about 40 other cities. The nine half-hour programs were produced for National Educational Television by the University of Houston station.

Fellowships

Facts about fellowships for health research provided by federal and non-governmental agencies are now available in a single report, "Fellowships for Health Research," issued by the National Health Council. Based on a meeting of the Council's Committee on Research, the report contains information about the fellowship and traineeship programs of four federal and twenty-two non-governmental agencies.

Copies may be purchased for $1.00 from the National Health Council, 1790 Broadway, New York 19.

Dedication Ceremonies

Western Washington College, Bellingham, Washington, will dedicate its new $2,500,000 Haggard Hall of Science in ceremonies December 1-4, 1960. The keynote address will be given by Dr. William H. Pickering, Director of the Jet Propulsion Laboratories. Dr. Linus Pauling will speak on molecular biology, and Dr. Paul F. Brandwein will discuss science education. Other topics to be dealt with by other speakers will include oceanography, cosmology, and related fields. Specific information about the program may be obtained from Dr. E. F. Neuzil, Department of Physics and Chemistry.

Looking Ahead in Science

A report of the Production Seminar and Conference on the Improvement of Science Education in the Elementary School, October 5-10, 1959, has now been published as "Looking Ahead in Science" by the California State Department of Education in Sacramento. This very fine bulletin has been produced by the Bureau of Elementary Education of the California school system.

Live Animal Study in the Beginning Zoology Course

A. M. HOLMQUIST
St. Olaf College, Northfield, Minnesota

For several years the observation of live animals has been a regular part of the laboratory procedure of our introductory zoology course. We have continued the practice these many years because it has been successful in student interest and achievement. Even though the students may many times have seen such common animals as the frog, the earthworm, or the grasshopper, most of them have never before taken time to observe their activities at close range. The students respond with much enthusiasm to this type of laboratory work, ask many questions, and give every indication that they are taking the work seriously and getting much out of the study. With adaptations, this type of study lends itself to both high school and college levels.

Live study of animals has many values to recommend it. It has helped to rescue the course from mere carcass study and to restore the course to its rightful place as a study of life. Live study furthermore lends variety to the laboratory schedule of work, gives the students a chance to see how the structures operate which they have just studied in the preserved specimens, corrects abnormal impressions of the animals such as faded colors and color patterns, shriveled skins, twisted or flattened bodies, abnormal positions of limbs, and other distortions. Live animals also demonstrate their natural movements and activities, and, perhaps, also their voices. There is also an opportunity to impress respect, understanding, and consideration for animals. Pithed or anesthetized animals can also be used to demonstrate the actions of internal organs; e. g., heart beat, blood flow, lung action, peristalsis, muscle contraction, and other internal activities. Making use of the live animal supply, one can use freshly killed animals to demonstrate the natural color, normal position, distensibility (e. g., lungs) of internal organs, to offset the abnormal impressions obtained from the decolorized, and often displaced, organs of the preserved specimens.

The live study follows the dissection or other morphological study of the organism in order that the student may first become familiar with the structures and their functions.

Live specimens of the animals to be studied in the course are collected or purchased just before their use in the laboratory if they are available at that time. They are in best condition and will show most normal activity when they are fresh from their native habitat. If they cannot conveniently be obtained at the time they are to be studied, they are collected when available in the fall or spring and maintained in the laboratory until needed. If they must be maintained in the laboratory for some time before use, they must be kept in good condition with proper food, regular feeding, water, light, space to exercise, and in as natural surroundings as possible. Interested members of the class may be enlisted to help collect the animals and maintain them in the laboratory and may thus see the natural habitats of the animals, methods of collection, and activities of the animals in the field. Usually these volunteer helpers become so enthusiastic and interested in the field work that their enthusiasm is passed on to the class when the animals are studied.

In all of these studies, it is important to keep the animals calm and unexcited so as to get somewhat normal responses from them. This is especially important in the live study of vertebrates and the higher invertebrates. To this end, the animals should be handled as little as possible. If handled, they should be handled gently and slowly. It is important to avoid quick, nervous movements of one's body and hands in or near the containers; slow movements do not excite them. Loud noises of all kinds should also be avoided. This small bit of technique in handling animals should be called to the attention of the students at the beginning of the study.

Control of the class often becomes more difficult during live study exercises. The stu-

dents often become noisy as they react to some sudden and unexpected activity of the animals. This can be forgiven since they are reacting for the most part honestly to their work.

One or two live specimens are gently placed in each glass container, and if possible, one or two containers per laboratory table. If the animals are terrestrial, the containers should be provided with a moist bottom of wet paper toweling or moist sand to prevent drying of specimens. If they are aquatic, enough water should be provided to allow the animals to swim in it freely. Battery jars, museum jars, glass food containers, finger bowls, Syracuse watch glasses, and aquaria may be used as containers. The size of the container depends upon the size of the animals to be studied. There should be ample room in the container for the animals to move about in it. If locomotion is to be observed, the size of the container must be several times the length of the animal. Precautions must of course be taken to prevent the escape of the animals, especially if they are terrestrial animals. The animals and their containers are set out on the laboratory tables at least a half hour before the beginning of the laboratory period in order to quiet them before the students arrive. As soon as the students arrive, it has been found necessary to caution them against disturbing the animals in any way until they have received instructions.

Three or four students can observe the animal at the same time if the specimen is large enough to be easily seen with the naked eye. A reading glass may be helpful for the smaller specimens or for smaller details, and a compound microscope may be necessary for tiny organisms.

If specimens are necessarily few, arrange for the students to make their observations in small groups at various times during the period.

The study is directed by numerous guiding questions on a duplicated work sheet or on a page in the laboratory manual. The questions are organized under such topic headings as size, color, posture, methods of locomotion, breathing movements, movements of body parts, speed of movements, degree of activity, method of feeding, responses to various stimuli, and the like. In some cases, simple experiments may be performed on responses to touch, light, moisture, temperature, and other ecological factors. The questions should be suggestive rather than complete in order to allow for some original observations by the students.

Quiet, patient watching is needed for best results. Occasional gentle handling or prodding may be necessary at times to stimulate the specimens to activity. If there are many sections in the course, it would be distinctly advantageous to have sets of fresh animals to replace the fatigued ones, especially if the animals have undergone much prodding or necessary handling.

The amount of time set aside in the laboratory schedule for live study work on a particular type of animal may vary from a whole period on such an animal as the frog to just a few minutes on such an animal as Hydra. The amount of time that may be devoted to the study of any given organisms may depend upon the amount of activity shown by the animal, the diversity of activity, the complexity of organization, and in general the number of observations possible on the animal. The amount of time also depends upon the instructor's objectives in the study. A mere quick look at a live animal has very little lasting pedagogical value in impressing the animal upon the minds of the students. There must be some effort expended in the live study to aid in retention and to overcome the dead aspects of dissection and other purely morphological study.

In order to secure serious attention from the students, it is necessary to demand that all observations be recorded and handed in at the close of the laboratory period. To save the students' time in recording the observations and the instructor's time in checking the papers later, the report is topically organized, and the notations made wherever possible in abbreviated sentences or even with one or two words. Thus:

> *Color:*—Dorsal side dull red, ventral side paler.
> *Size:*—Body length 6 inches when relaxed.
> *General activity:*—Sluggish. Movements slow. Animal spends much time lying quietly in the corner of the jar.

It should be made clear to the students that this abbreviation of statements does not mean

a curtailment of number of observed facts but on the contrary allows more time to record more facts. Duplicated form sheets could be used to speed up the recording of observations and to facilitate checking by the instructor.

Radiation and High School Teaching

DONALD J. FLUKE, Director
Duke University Summer Institute in Radiation Biology, Durham, North Carolina

Radioactivity is becoming a high school classroom staple. Geiger counters share bench space with microscopes, and fume hoods are bright with the yellow and magenta colors of the Atomic Age. Both in quality and in quantity the quiet innovation is paced by a program, now in its fifth year, in which the Atomic Energy Commission, The National Science Foundation, and over a score of universities join in training and equipping high school teachers. Several things are immediately impressive about the program: its present size, the eager acceptance and exploitation of its possibilities by teachers, and the careful and varied manner in which its growth has been guided.

In terms of size approximately 750 teachers have already received from six to eight weeks of intensive summer training. Approximately 400 more are scheduled for this summer. In our own institute at Duke University Marine Laboratory every participant and visitor is caught up by the enthusiasm with which the new group of twenty each summer tackles the unusual assignment, an enthusiasm which continues to come back to us in letters filled with clippings, questions, and comments on how it works out in the classroom. When a high school teacher with years of experience writes back to say, "This fall seemed like my first year teaching again instead of my thirteenth," we know that we have something good going.

The program began with three summer institutes in 1956, one each at Harvard, Duke, and the University of New Mexico. Although designed primarily for biology teachers, the institutes have from the start included teachers of physical subjects as well. In succeeding years the program has grown to five and then to twelve institutes, and last summer to nineteen, including two for college teachers. National meetings of institute representatives have helped new institutes to build on the experience of older ones and to find their own special improvements.

"Radiation Biology" has been the guiding title, but in most of the institutes radioactive tracer technique has received a more substantial effort than has practical study of radiation effects. The area of interest may not be very logically defined, but it meets the test of pragmatism. A high school teacher can more easily and safely use P^{32} in tracer quantities than he can a cobalt source or X-ray machine capable of damaging living things. Work with tracers fits immediately into analytic uses. At the same time the teacher can talk about atomic reactors, the balance between hazards and uses of radiation, and the whole spectrum of radiation biology in relation to policy and to society.

Each teacher is provided with a kit of equipment for high school use. The kit includes a scaler-ratemeter with Geiger counters capable even of C^{14} work, an electroscope, a diffusion cloud chamber, supplies for autoradiography, and numerous smaller items. Of equal importance are supplies of radioisotopes sent twice a year to each institute graduate who requests a shipment. Exempt quantities of nine or ten different materials are included, allowing a variety of classroom uses. The preparations made for the arrival of these shipments are reflected even in the local press. Boxes are opened by rubber-gloved hands over paper-covered pans, while disciplined crews of student helpers hold implements and Geiger probe monitor at the ready. The way these teachers organize things no student can miss the fact that the Atomic Age arrives twice a year in a package of little vials.

What can a high school teacher do with ten microcuries of P^{32} or similar materials? Many of the teachers undertake some exer-

cises in counting technique first, teaching the use of radiation detectors, and also pointing up a beautiful example of the statistical nature of measurement. Within the same basic context some have devised ingenious demonstrations of the inverse square law, an unexpectedly popular activity. Then they go on to translocation exercises with plants. The student, who puts a bean seedling briefly into a P^{32} solution and then cuts up the plant and counts each part before and after drying, learns something about movements of dissolved materials inside plants. Demonstrations of diffusion and osmosis are high on the popularity list. The chemically-minded work out solubility products, demonstrating and utilizing the tremendous sensitivity of tracer methods. Some show I^{131} uptake in thyroid or follow red blood cells with Cr^{51}.

While it would be much harder to injure anyone or anything with 10 microcuries of P^{32} than with even small amounts of sulfuric acid, mercury, or ether, for example, the teachers undertake exaggerated precautions, mostly for instructive value. The program is not only safe for the high school class, but it teaches radiation safety.

Most of the teachers use plants more often than animals, partly because of the greater simplicity of handling plants. Radioactivity put into a mouse can get out of the cage and run around. It might even be eaten by the school cat, a kind of inadvertent food chain study which most teachers wish to avoid. But for those who do undertake animal work, partly because of the pedagogical value of animals, the nature of the tracer quantities of radiation allow many informative exercises without harm or trauma to the animals. The teacher has available subtle tools which make easier the respect for life which must always be inherent in good biological teaching.

How does the radiation institute program work out for the high school student? Have many been influenced toward basic work sooner in preparation for science careers? We know that institute-trained teachers have turned out science fair winners and have put science clubs into better competition with other extracurricular attractions. We have had college freshmen stop by with greetings from a teacher we trained but have yet of course to get our first graduate student possibly influenced toward quantitative work by the radiation institute program.

These things show up, but from the vantage point of an institute director most of the iceberg is hidden. What we do see is the teachers, and what we see of them encourages us very much that the ultimate beneficiaries are getting everything we could hope and more. Status is a currency of the times, and our teachers demonstrably go back home with some. A high school teacher, who has dug hard on basic radiation science all summer, has heard a number of radiation research scientists, has talked till all hours with his colleagues from over the country, and comes home with a very tangible set of mysterious modern gear, is not quite the same man or woman. Unless he lives in a university city he is probably the local radiation expert, and he knows it. He is ready for the school assemblies, PTA meetings, and Lions Club talks that can let him get at some of the questions that students *and* adults will find he can discuss. Our participants have originated TV series based on their training, have served on state advisory boards for radiation, have taken prominent part in Civil Defense activities, and have even done some commercial consulting on the side. The high school teacher who rides that kind of wave of topicality, even for just a time, is on a new basis in the classroom, a focal point for student interest, a galvanic center for student activity. For at least one institute director the greatest fun of the whole program has been seeing the high school teachers go out with a new enthusiasm in their profession, and to have the opportunity of helping keep that excitement glowing.

Journal of Biology—1960

The very excellent publication by the students in the Biology Department of the Bronx High School of Science is now available as the *Journal of Biology—1960*. It may be obtained from the school, 75 West 205th Street, New York. Dr. Jerome Metzner is chairman of the department, and this latest issue is another evidence of what fine work high school students can do. Biology teachers will be quite interested in reading about the research projects which these students have carried on.

Report on a Florida Science Study Program*

DORIS TIMPANO
Jamaica High School, Queens, New York

This report represents a summary of the activities of a group of honor science students from Jamaica High School, Queens, New York, during the Christmas holidays, December, 1959. The program was motivated last July when I participated in a National Science Foundation Program for biology teachers at the Archbold Biological Station, Lake Placid, Florida, under the direction of the American Museum of Natural History. While studying field biology in the Everglades, I conceived the idea of sharing this unusual and very wonderous experience with my students. The following program is the result of my determined effort to enable our students to have similar experiences.

Thirty-six biology students from our high school participated in THE FLORIDA SCIENCE STUDY PROGRAM. These students were selected on the basis of their interest in the biological sciences and on their scholarship. They studied, traveled, and constantly observed the wide range of biological phenomena on their own time and at their own expense. The purpose of this program was to enrich their biology curriculum through unusual field experiences. The activity-packed program began at Pennsylvania Station in New York on December 26 when we departed by rail for Daytona Beach, Florida. This eight-day study program, entailing over thirty-five hundred miles of travel, took us throughout the interesting state of Florida and ended on January 3 with our return to New York and the return to our classes.

Highlights of the program included: Visits to Silver Springs, Cypress Gardens, and the Parrot Jungle; Lecture and trip through a pineapple plantation; Botany program at the Highlands Hammock State Park; Visit to the Archbold Biological Research Station as guests of Richard Archbold and discussions with scientists working at the station about their research projects; Everglades orientation and lecture programs conducted by the rangers and naturalists; Trips through the Everglades by catwalk, bus, and boat; University of Miami science program conducted by Dr. H. Leigh; Orientation program in marine biology at the Seaquarium.

While traveling from one point to another, the students experienced the unusual in science education. They were members of a new kind of school—a classroom on wheels. Our bus was equipped with a microphone over which I was able to conduct "class." We discussed what we had seen and what we were soon to see. We reviewed recently learned ideas and connected them with our school work. We refined our methods of observation as we were trained how to look for the plants and animals we studied. As we traveled down Florida's central scenic route, we observed examples of biological principles in operation. Once, our bus stopped while our ranger-guide jumped out and attempted to catch an Indigo snake for our examination. Students learned, first-hand, how quickly a snake will react. We lost our snake!

Immediate Accomplishments

A. Although we were primarily concerned with the observation and collection of factual information, in our classroom sessions we constantly strived to arrive at the larger biological concepts which were to be obtained from our experiences. Following are some of the many principles and concepts enumerated by the students during our evaluation sessions.

1. Evolutionary concepts stressed—particularly,
   a) survival of the fittest
   b) natural selection
   c) variations within a given species
   d) mutations and their place in modern evolution
2. Plant and animal adaptations were in abundant evidence.
3. Parasitic, symbiotic, saprophytic and host relationships were observed, discussed and better understood.
4. Taxonomy, its purposes and functions, was better understood as the

*The author reports that several civic groups have expressed an interest in helping finance this unusual field trip during Christmas vacation.

students familiarized themselves with terminology and the keys to plants and animals.

5. Applied conservation was illustrated by rangers. Their comment, "Take only a snapshot, leave only your footprint," was a good lesson in the preservation of natural habitats.
6. Controlled burning of forest areas in the Everglades illustrated the principles of succession which the rangers were trying to prevent.
7. Details of the scientific method were observed in practice and indelibly recorded in the minds of students as they watched scientists at their work.
8. The drudgery and the discipline of science were stressed.
9. Students learned why the Everglades National Park was set aside and the need for the preservation of natural habitats for the maintenance of the continuance of some species.
10. The variety of plant and animal life was clearly observed by the tremendous abundance of natural life found only in Florida where the temperate and the sub-tropic zones meet and mingle to form a habitat unique in the continental United States.
11. Dramatic illustrations of plant tropisms were observed and explained.
12. Students also gathered information about the social, economic, political and historical background of Florida which will enrich their general knowledge.

These were some of the scientific concepts that we emphasized. It is very true that these students have already learned some of these ideas from more traditional sources such as textbooks, and academic work; however, it is equally true that they will not soon forget these concepts which were so well illustrated before their own eyes. To this end, this program was dedicated.

B. All of the students participating in the program evidenced deep interest in returning to Florida either with this group or with their parents and friends to study and stay in the Everglades for a longer period of time.

C. The students, in their desire to continue learning about the interesting places they have visited, are planning to form a science club which will enable them to continue to build upon the knowledge they have gained and will enable them to teach others what they have learned. Some of the students plan to learn more about the Florida bird life already seen; others plan to delve deeper into Everglades ecology.

D. Students and teacher-guides alike kept records of the program in several ways. Some kept journals; others took movies, snapshots, and slides. A fine collection of color slides which illustrate many phases of our science activities is now available for showing to interested clubs, organizations, and other science programs without charge.

E. The trip was not completely science. Where possible, the students took advantage of the opportunity to swim, fish, and sunbathe. It is interesting to note that even during their leisure moments, many students pursued activities of a semi-scientific nature. Some chose to go deep-sea fishing; others collected shells, crabs, coconuts, marine life, and other science materials.

Evaluation

It is difficult to evaluate a program of this nature. The results may not be evidenced for many years. Of this, I can be sure, each student, in his own way, will remember this program as a highlight in his high school learnings and will be influenced by it. Field biology has become to them an interesting and exciting experience. Each participant has already evidenced increased maturity and emotional development as a result of this unique experience. He has learned to accept adult responsibilities in a new situation of living and working together toward the goals of learning enrichment. This represents preparation for future adult living.

Future Programs

At present, we are planning similar pro-

grams to include science work in the Florida Keys in addition to our present areas of concentration. Greater participation from Florida scientists is anticipated in future programs because of their excellent response to our enthusiastic youngsters. Other science groups are evidencing interest in participation in the planning and implimentation of this program. Civic groups are being encouraged to provide scholarships for future programs to enable deserving science students to broaden their science horizons.

Audio-Visual Report

"An Experiment in the Use of Films for the Inservice Training of High School Chemistry Teachers," is a report of 18 pages now available from Samuel Schenberg, Director of Science, Board of Education, City of New York.

Conservation Publication

A recent publication, "Snow Surveys and Water Supply Forecasts," is available from The Soil Conservation Society of America, 838 Fifth Avenue, Des Moines 14, Iowa, for $0.50 per copy.

New Bibliography

"Suggested Science Books for the Pupil and Teacher," a new publication of the College of Education, State University of Iowa, Iowa City, Iowa, is now available from the Extension Division at ten cents per copy. Especially useful for teachers of K-9.

Slippery Skins of Germs

The slippery skins of germs—key factors in the body's defense against disease—are begining to give up their secrets. Chemical studies have established a relationship between the chemical structures of these "skins," known as polysaccharides, and the body's ability to produce germ-fighting antibodies, reported Dr. Paul Rebers, assistant professor of immuno-chemistry at the Rutgers Institute of Microbiology. Of the more than 70 different polysaccharides associated with the pneumonia germ, the chemist has determined the chemical structure of one. The structure of only two others has as yet been determined. The amount of antibodies produced to fight a germ depends on the type of sugar molecules and how they link together in the polysaccharide.

"Certain proteins in the blood stream of disease-immune animals, called antibodies, are able to combine specifically with the disease-causing bacteria, often by means of the surface polysaccharides and sometimes through proteins," the biochemist explained. "This combination is an important step in the body's defense system. The nature of this combination is highly specific depending upon the strain of bacteria, which in turn is related to the chemical structure of its surface."

Chemical Trap

A chemical trap that captures an important vitamin in corn, making it nutritionally unavailable, has been detected in research reported by a chemist of the United States Department of Agriculture.

The existence of the trap—which holds the niacin, a B-vitamin, at 1,000 times the concentration at which it occurs in whole corn—was confirmed in rat feeding tests, described by Donald D. Christianson of the U. S. D. A. Northern Utilization Research and Development Division, Peoria, Ill. A better understanding of the relation between high-corn diets and pellagra, a niacin-deficiency disease which attacks the nervous and digestive systems is expected from the studies, he said.

The problem of the poor nutritional utilization of niacin in corn has been recognized for many years, and it was previously suggested that the niacin of corn was chemically bound in a manner that made it unusable by animals. Interestingly, Dr. Christianson said, in countries where tortillas are a common food, there is less pellagra than in other high-corn consuming areas. Alkaline treatment of corn during tortilla manufacture may liberate the niacin, he stated.

Nominations for 1961 Officers

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

In accordance with the constitutional provision on elections, a Nominating Committee was appointed by President Howard Weaver. Members were: Paul Klinge, Chairman; Frances Gourley, Brother Charles, Richard Weaver, and Irving Keene. Their nominations are presented below. Ballots will be mailed shortly.

A new feature of this year's election will be the election of Regional Directors. Their duties will be to represent their regions on the Board of Directors, to promote regional activities, and to initiate teacher award programs. Their biographical backgrounds will be carried in the December issue.

Officer duties, briefly, are: President-Elect, prepare for presidential duties and arrange AAAS meeting; First Vice-President, substitute for President and arrange AIBS meeting; Second Vice-President, substitute for First Vice-President and promote affiliate memberships; Third Vice-President, substitute for Second Vice-President and in charge of membership promotion; Secretary-Treasurer, keep records, disburse and receive funds, and receive membership dues; and Recording Secretary, keep official Board minutes and have stationery printed.

Candidate for President-Elect

Muriel Beuschlein

Present Position: Associate Professor of Biology, Chicago Teachers College, Chicago, Illinois.

Degrees: B. E., Chicago Teachers College. M.S., Northwestern University. Finishing Ph.D., June, 1961, Northwestern University.

Experience: Science teacher in junior high school for 7 years. Film advisory committees, AIBS and Indiana University. Coordinator for program of teaching societies, AAAS, 1959. Coordinator, 4 in-service courses, Chicago Teachers College and Chicago Academy of Science.

NABT Activities: Managing Editor, ABT, since 1951. Chairman, Illinois Conservation Committee, Chicago Membership Committee, Constitution Revision Committee, Policies Committee. Member, Liaison Committee and Affiliation Committee.

Organization Membership and Activities: Fellow, AAAS. Member, NARST, CASMT, NSTA, CESI, and CEA. Panelist, National Science Foundation. Secretary, Sigma Delta Epsilon.

Publications: Articles in ABT, CASMT, and other professional journals. Booklets: "Free and Inexpensive Materials for Conservation and Resource Use Education," Interstate Printers, 1958; "Free and Inexpensive Materials for Science Education," *Chicago Schools Journal*, 1959. Co-author: "Things to Do in Science and Conservation," Interstate Printers, 1960. Educational author of films and filmstrips.

Candidate for President-Elect

Frances M. Gourley

Present Position: Biology teacher, LaPorte High School, LaPorte, Indiana. Biology instructor, Purdue University Extension Center, Michigan City, Indiana.

Degrees: B.S. and M.S., University of Illinois.

Experience: High school teacher in Illinois and Indiana for 25 years. Biology instructor, Purdue University Extension Center, 5 years. Senior Counselor, High School Science Student Institute, Indiana University, 1959-1960. President, Biology Section, Indiana State Teachers Association, 1957-1960. President, Biology Section, Central Association of Science and Mathematics Teachers 1950-1951.

NABT Activities: National Membership Chairman, 1947-1951. Member, Executive Board. Editor, *News and Views of NABT*, 1958-1960.

Organization Membership and Activities: Member, NABT, CASMT, AAAS, AIBS, ISTA, Delta Kappa Gamma, Indiana Audubon Society, Indiana Academy of Science. President, Conservation Section, CASMT, 1958-1959. Member, Executive Board, CASMT.

Candidate for First Vice-President

Clarence J. Goodnight

Present Position: Professor of Zoology, Department of Biological Sciences, Purdue University, West Lafayette, Indiana.

Degrees: B.S., M.A., Ph.D., University of Illinois.

Experience: Teaching and research assistant. University of Illinois. Instructor in Biology, Brooklyn College, University of Illinois, Jersey City State Teachers College. Research associate, American Museum of Natural History, New York. Co-director NSF Summer Institute for High School Biology Teachers, New Mexico Highlands University. Director, NSF Summer Institute for Biology Teachers, Purdue University. Research at Cold Spring Harbor, New York, and Friday Harbor Marine Station, State University of Washington. Co-ordinator of teaching activities in Department of Biological Sciences, Purdue University.

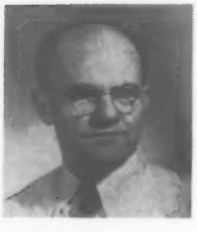
NABT Activities: Organized symposium on teaching of invertebrate zoology for AIBS meetings at Stillwater, Oklahoma.

Organization Membership and Activities: Member, Sigma Xi, Phi Beta Kappa, Indiana Academy of Sciences, Society of Systematic Zoology, Ecological Society of America, Society of Zoologists, Society for the Study of Evolution, Nature Conservancy, American Microscopical Society, American Society of Limnology and Oceanography, Association of Midwest Biology Teachers, NSTA. Fellow, AAAS.

Publications: Author of numerous articles in various scientific journals. Author of article and book reviews for *American Biology Teacher*. Co-author, zoology text and laboratory manual. Co-author with Paul Klinge and R. R. Armacost of high school biology text (in press). Co-author of college biology text (in press) with R. R. Armacost and M. L. Goodnight.

Candidate for First Vice-President

Stanley B. Mulaik



Present Position: Associate Professor of Zoology, University of Utah, Salt Lake City.

Degrees: B.S., State Teachers College, Pennsylvania. M.S., Cornell University. Ph.D., University of Utah.

Experience: Grade school and high school teacher in Pennsylvania. Consultant, instructor, and director for nature study in camps in Pennsylvania, New Hampshire, and Texas. National staff of Girl Scouts as nature study director. Consulting specialist, Dugway Ecological Laboratory. Associate Director, NSF Summer Institute, University of Utah. Research grants (NSF).

NABT Activities: Consultant, NABT North Central States Biology Teachers Conference, 1955. State membership chairman, Utah. Member, Conservation Committee.

Organization Membership and Activities: President, South Texas Science Teachers Association. Editor, Newsletter, ANSS. Vice-President, Conservation Education Association. Member, NARST, Sigma Xi, Utah Academy of Science, Wilderness Society, Soil Conservation Society of America, State General Science Curriculum Committee, NSTA, State Conservation Education Council, Biological Society of Washington, Entomology Society of Washington, AAUP, Nature Conservancy, Society of Systematic Zoologists. Fellow, AAAS, Texas Academy of Science. Member, Natural Resources Council of America. Past President, Western Section, ANSS. President, ANSS, Utah Nature Study Society.

Publications: 35 papers in zoology.

Candidate for Second Vice-President

Sister Hilaire

Present Position: Chairman and Professor of Biology, Rosary College, River Forest, Illinois.

Degrees: A.B., M.A., and Ph.D., University of Illinois.

Experience: 39 years of teaching at college level. Professor of Biology, College of New Rochelle, New Rochelle, New York. Participant, School and College Workshop, University of Chicago. Participant, Summer Institute for Teachers of College Botany, Cornell University.

NABT Activities: Participant, North Central States Conference for Biology Teachers. Member, Illinois State Membership Committee. Chairman, Catholic Membership Committee.

Publications: Microthyriaceae, *Mycologia* and *University of Illinois Monograph* series. Effects of Water Source on Toxicity of Mercurial Poisons, *Journal of Heredity*, 1951.

Candidate for Second Vice-President

Brother G. Nicholas, F.S.C.

Present Position: Research Associate, Department of Biology, Notre Dame University, Notre Dame, Indiana. Instructor, Holy Cross School of Nursing, South Bend, Indiana.

Degrees: B.S., Catholic University. M.S., University of Pittsburgh. Ph.D., University of Notre Dame.

Experience: Biology Teacher. LaSalle High School, Cumberland, Maryland. Directed excavations, Cumberland Bone Cave.

NABT Activities: Member, Cooperative Committee of AAAS, Membership Committee. Chairman, State Membership Committee. Assistant editor, ABT.

Organization Membership and Activities: President, National Speleological Society. Fellow, AAAS. Member, Council of AAAS, New York Academy of Sciences, Pennsylvania Academy of Science, Society of Systematic Zoologists, Society of Mammalogy, Phi Beta Kappa, Sigma Xi, Alpha Epsilon Delta, Teacher Preparation Committee of BSCS, AIBS.

Publications: Checklist of Macroscopic Troglobitic Organisms of the United States, *American Midland Naturalist*, July, 1960. Articles in *ABT*, *Science*, *Scientific Monthly*, *Scientific American*, *Proceedings of the Pennsylvania Academy of Science.*

Candidate for Third Vice-President

Robert L. Smith

Present Position: Chairman, Biology Department, DeKalb High School, DeKalb, Illinois.

Degrees: B.E., Illinois State Normal University, M.A., (zoology), University of Michigan.

Experience: State chairman, Illinois Junior Academy of Science, 1949-51. Elementary science consultant, Illinois Department of Public Instruction. Participant, Darwin Centennial Celebration, University of Chicago.

NABT Activities: State and Regional Chairman, Conservation Project. National Membership Chairman since 1955. Participant, North Central Conference on Biology Teaching.

Organization Membership and Activities: Member, ANSS, NSTA, Illinois Junior Academy of Science, Northern Illinois Association of Biology Teachers.

Publications: Contributing author, *NABT Conservation Handbook*. Article on biology clubs in ABT.

Candidate for Secretary-Treasurer

Herman C. Kranzer

Present Position: Associate Professor of Elementary Education, Teachers College, Temple University, Philadelphia, Pennsylvania.

Degrees: B.S., (forestry), M.A., (education), University of Michigan; Ed.D., U.C.L.A.

Experience: Taught science and conservation, Work-Learn Camp for Older Youth, Michigan; Teacher-counselor, Clear Lake Camp, Battle Creek Schools. Outdoor Education Director, Culver City, California. Director, Conservation Workshop, West Chester State College, Pennsylvania. NDEA lecturer in elementary science. Director, Conservation Education Laboratory for Teachers, Pennsylvania State University. Assistant Professor of Science Education, Pennsylvania State University.

NABT Activities: Secretary-Treasurer, 1960.

Organization Membership and Activities: Member, NSTA, Pennsylvania Science Teachers Association, Conservation Education Association, Phi Delta Kappa. Board of Directors, Pennsylvania Forestry Association. NSTA Teaching Materials Review Committee.

Publications: Education in the Out-of-Doors, Pennsylvania School Study Council. Bulletin of the Michigan Secondary School Association. *A Community School Work-Learn Camp*, Michigan Department of Public Instruction. Article in *Metropolitan Detroit Science Review.*

Candidate for Recording Secretary

Frances L. Behnke

Degrees: B.S., M.A., University of Arkansas. Ph.D., Teachers College, Columbia University.

Experience: Science teacher, Little Rock, Arkansas, and Atlanta, Georgia. Faculty, Barnard College and Hunter College. John Hay Whitney Fellow, Columbia University. Member, Science Manpower Project. Consultant, Thomas Alva Edison Foundation.

NABT Activities: State chairman, Conservation Project. Local chairman, AAAS meetings. Member, Local Arrangements Committee, AAAS meetings, 1956. Participant, North Central Conference for Biology Teachers.

Organization Membership and Activities: Vice-President, Iota Sigma Pi. Member, AIBS, Georgia Academy of Science.

Candidate for Recording Secretary

Audrey E. Pressler

Present Position: Biology Teacher, Frederick High School, Frederick, Maryland.

Degrees: A.B., Hood College. Candidate for M.S., University of Michigan.

Experience: High school biology teacher for many years. Participant, NSF Summer Institute for teachers of High School Biology, Indiana University; Writing Conference for Sourcebook, Michigan State University. Awarded NSF fellowship for University of Michigan. NSTA STAR program winner.

NABT Activities: State Membership Chairman, Maryland. Member, Conservation Committee. Local chairman, AAAS meetings, 1958.

Organization Membership and Activities: Member, NEA, NSTA. Reviewer, AIBS Film Series, Member, Welfare and Nominating Committees, Maryland State Teachers Association. Treasurer and Vice-President, Maryland Science Teachers Association. Secretary and Member of Board of Trustees, Maryland Biology Teachers Association. Member of Executive Committee and Chairman of Teacher Welfare Committee, Frederick County Teacher's Association. Corresponding Secretary, Frederick County Science Teachers Association. Past President, Junior Woman's Club and Frederick Hood Club.

Publications: Article in *The Science Teacher*. One of authors, *Laboratory and Field Studies in Biology*.

Book Reviews

THE CELL, FOUNDATIONS OF MODERN BIOLOGY SERIES, Carl P. Swanson, 114 pp., $1.50, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1960.

An auspicious begining for a series which should be on every biology teacher's bookshelf. Well illustrated, this slender paper-backed volume is written in an easy, readable, but information-packed style. The author includes in this effort to present the latest in cytology, something of the history of the cell concept, exceptions to its generalities, tools and techniques, structure and metabolism, mitosis and meiosis, reproduction in plants and animals, embryology, and cell death. The DNA concept is thoroughly taken up, and the role the cell plays within the history of the organism is an outstanding feature. There is no undue emphasis on structure, but whenever it is taken up it is tied to metabolism. The treatment of cell growth incorporates much of the new concepts of embryology. Heartily and enthusiastically recommended.

P.K.

GENETICS NOTES, Fourth Edition, James F. Crow, 149 pp., Burgess Publishing Company, Minneapolis, Minnesota, 1960.

This is a spiral-bound book by a distinguished geneticist which is precisely what its title implies —notes for a genetics course. The right hand pages are consistently blank for right-hand writers who want to take further notes. The book is engagingly and simply written—a fine capsule summary of the major genetic concepts. Each chapter ends with excellent problems. The book progresses rapidly from Mendelian laws, and within nine chapters is into biochemical genetics and ends with material on the origin of life. Recommended for those teachers whose genetics courses were sometime ago as well as the neophyte who is just beginning.

P.K.

THE EDUCATION OF TEACHERS: CURRICULUM PROGRAMS, Kansas TEPS Conference, 453 pp., $3.50, National Education Association of the United States, Washington, D. C., 1959.

This is the next conference report in the series begun at Bowling Green, Ohio. As the title indicates, the primary emphasis is on teacher preparation rather than certification. The NABT was represented in this conference although no elaborate emphasis is made on science teacher preparation. In large measure, the Garrett report, prepared under the auspices of the Cooperative Committee of the AAAS, is the basis for the recommendations for science teachers. The introduction is an excellent summary of the details. Individual college programs for teacher preparation are summarized. Any one interested in this area will have this volume available.

P.K.

THE SEAHORSE AND ITS RELATIVES, Gilbert Whitley, Joyce Allan, 84 pp., $6.00, Charles T. Branford Company, Boston, Massachusetts, 1958.

A delightful, little Australian book on seahorses and their relatives. There are numerous illustrations. Anatomy, habits, classification, and their very interesting and unusual sex life are told in an interesting style. One chapter on culturing the fish should be of particular interest to teachers.

P.K

GOOD HEALTH, Benjamin F. Miller and Zelma Miller, 546 pp., $6.00, W. B. Saunders Company, Philadelphia, Pa., 1960.

A very good high school and freshman college text directed to those areas of study which rightfully belong to health education. The authors have made a direct approach to the problems of maintaining good health, thus avoiding any negative, moral, or morbid attitudes.

Use of this book would eliminate the common practice of many teachers and texts to make the course one of physiology and anatomy. Certainly the use of this book would be more meaningful following a good course in biology; however, the presentation is such that this is not imperative. The subject matter is such as to make the student aware of his responsibility for public health as well as for himself.

Virgil Heniser
Howe High School
Indianapolis, Indiana

MEDICINAL PLANTS OF THE ARID ZONES, UNESCO, 96 pp., $3.00, Columbia University Press, New York, 1960.

This booklet, Part XIII in the UNESCO Arid Zone research series, considers the botanical and pharmacological aspects of a number of higher plants of the more arid regions of the world. Particular attention is also given to the commercial possibilities. An extensive bibliography is included.

SCIENCE MATERIALS—PREPARATION AND EXHIBITION FOR THE CLASSROOM, GORDON G. Pond, vi + 132 p., $2.75, Wm. C. Brown Co., Dubuque, Iowa, 1959.

The biology teacher's desk is the frequent repository for animals, plants, rocks, and an almost infinite array of objects brought by students to "show the teacher." Most teachers are happy to have students express their interest by bringing in these specimens and use them to teach the student something about science. One of the best ways to encourage this kind of activity is to have the student prepare their specimens for display to other students. Pond's little book contains information about how to prepare these displays and the more formal exhibits used for teaching purposes. Information is included on the preparation of labels and setting of displays of materials in anthropology, geology, paleontology, zoology, and botany. Illustrated directions are given for making models, plaster casts, plastic embedded specimens, study skins, herbarium specimens, and many other kinds of preparations. A short section on the presentation of projects for science fairs is included.

This book is set up for use as a text by the inclusion of perforated quiz sheets at the end of each chapter. Its primary value, however, is as a reference source rather than as a textbook.

John M. Hamilton
Park College
Parkville, Missouri

THE WILD MAMMALS OF MISSOURI, Charles W. Schwartz and Elizabeth R. Schwartz, xvi + 341 p., $5.95, University of Missouri Press, Columbia, Missouri. 1959.

The Missouri Conservation Commission has been fortunate for many years to have the services of Charles and Elizabeth Schwartz. The former is an artist with the knack of capturing his subjects with his pen so that they look alive, yet clearly illustrate taxonomic details. Together, the Schwartzes have produced exceptional wildlife films, books, and articles.

This book contains fifty-seven full page plates, each devoted to a single species. Most of these plates include drawings of the animals in their natural environment; dorsal, ventral, and lateral views of the skulls, feet, and other taxonomic details. In addition, one or more figures is to be found on each page of text. These show the distribution in North America, ecological characteristics, tracks, and other aspects of the life of the mammals discussed. The text, written for the non-specialist, contains a wealth of useful information presented in a delightful manner. In addition to descriptions of the animals, there are discus-

sions of the habits, homes, foods, and economic control and importance of each of the major species described.

Because of the diversity of habitats provided by the state, *The Wild Mammals of Missouri* includes most of the mammals found in Central United States and is useful over a much wider area than the title implies. The price is unusually low for a book as well illustrated as this one.

John M. Hamilton
Park College
Parkville, Missouri

A LABORATORY MANUAL FOR LIFE SCIENCE, Herbert Drapkin, iii + 129 p., $2.40; N-P Publications, Palo Alto, California, 1959.

This is a manual for a one-semester course in biology for non-science majors. Much of the work is on living or freshly killed organisms, and many of the exercises involve simple experiments by students working in groups. The directions are clearly written, and they should contribute to the learning process of the student. Numerous optional experiments are suggested. Except for an exercise on Protozoa, the work is limited to vertebrates and higher plants. Four of the exercises are on systems of the fetal pig. There are no exercises on embryology or ecology.

John M. Hamilton
Park College
Parkville, Missouri

WARD AND WHIPPLE'S FRESH-WATER BIOLOGY, 2nd ed., W. T. Edmondson, Ed., xx + 1248 p., $34.50, John Wiley & Sons, New York, 1959.

Ward and Whipple's *Fresh Water Biology* played such an important role in turning my interests to biological science that it seems appropriate that I abandon tradition and review the new edition in the first person. One can hardly speak of an old friend in the impersonal way that one is expected to write book reviews.

In the late twenties, When I was in high school, my teacher had a shelf of books in his classroom which he encouraged students to read during the noon hour and after school. I remember just two of these: Slosson's *Creative Chemistry* and Ward and Whipple's *Fresh Water Biology*. I used to thumb through the latter endlessly, wondering at the diversity of animals to be found in ponds and streams and learning that it was possible to find the names of these creatures and something about their habits. I was determined that someday I would own a copy of that book. It was several years before I did, but for twenty-five years I have been reaching for my copy first when trying to identify a strange animal, knowing that the answer I would find would be out of date, but this book always seemed to be the logical place to start. Certainly it was an important factor in starting me on the road toward becoming a biologist. I think that this is a good example of something that we teachers tend to forget—that the right book placed in the hands of a student at the right time may do more to stimulate him than our most brilliant class presentation or our most carefully prepared laboratory exercise.

The total format of the new *Fresh Water Biology* is similar at first glance to the old, but is, at last, brought up to date. It is still essentially a book of illustrated keys, with introductory material for each group to enable the nonspecialist to make a tentative identification of his specimen. W. T. Edmondson has made wise decisions in the changes that were made in the second edition of this work. The internal parasites, H. B. Ward's specialty, have been omitted since they are not truly aquatic except for brief free-swimming stages. The aquatic vertebrates have been excluded since there are other books in which they are covered much more completely than could be done in a work of this size. The spiders associated with the water are also excluded. On the other hand, the bacteria and the vascular plants have a much more complete coverage than in the first edition. The bryophytes, tardigrades, and polychaets which were not included in the first edition are treated here.

Each chapter is devoted to a major taxonomic group and is treated by a specialist. The authors include such well known biologists as F. K. Sparrow (Fungi), L. E. Noland (Ciliophora), L. H. Hyman (Coelenterata and part of the Turbellaria), H. B. Hungerford (Hemiptera), H. S. Conard (Bryophyta), and many others. Two workers W. R. Coe (Nemertea) and J. P. Moore (Hirudinea), have revised the sections they wrote for the original edition published in 1918. Edmond-

son's chapter on the rotifers should make it possible for a student to identify many of the specimens he encounters of this difficult group. As in the old edition, the figures which accompany the keys are a great help in identification.

I am sure that most fresh-water biologists join me in welcoming this new edition of an old friend. It is unfortunate that the publishers found it necessary to set the price so high, for this will keep the new Ward and Whipple from the shelves of many biology teachers where its presence might stimulate students to choose biology as their field of study.

John M. Hamilton
Park College
Parkville, Missouri

DR. CARLOS J. FINLAY, BOOKLET ON SANITATION HISTORY, 140 pp., Ministry of Health and Hospital's Assistance, Havana, Cuba, 1959.

An addition to the library on the history of science. Published on the occasion of Dr. Finlay's nomination to the Hall of Fame, all the pertinent documents concerning his life and his scientific discoveries are compiled here.

P.K.

HUMAN DEVELOPMENT, Phyllis C. Martin, Elizabeth Lee Vincent, William A. Osburn, 541 pp., $6.50, Ronald Press Company, New York 10, 1960.

This is a most unusual book for elementary college courses in human anatomy and physiology. Written with strong overtones of psychology, embryology, and developmental anatomy, the treatment of this traditional course should be considerably enlivened by the use of this book as a text. When psychological ideas are presented, it is done with direct reference to the human body, anatomically and/or physiologically. Each body system also includes some embryological development. It seems, all in all, a most appropriate text for the age level of students normally in college classes.

Written in quite a readable style, the authors are to be congratulated for packing into each chapter a wealth of information presented in a way students will enjoy reading about. Chapter end material includes a selected list of appropriate films.

The chapter on skin was most fascinating with information seldom found in this type of text. But to the biologist, it will be a pleasure to find man described continually in reference to his place in the biotic and physical world. A listing of chapter headings may give a false impression that this is just another anatomy and physiology text. But a reading will convince the teacher that this is truly a text to consider.

P. K.

OPERATION NEW YORK, USING THE NATURAL ENVIRONMENT OF THE CITY AS A CURRICULUM RESOURCE, 117 pp., $1.00, Board of Education of the City of New York, 1960.

One of the most unusual little volumes to cross this editor's desk. Even the way it was written has a flair not found in most books. This is the result of a curriculum study carried out by persons with a variety of backgrounds and then tested. The result is not the usual report, but it is a resource book on how to use an urban environment for biological education. It is truly a unique volume.

Although it is tailored for the New York City area, other urban biology teachers can learn a great deal from this. It starts with a study of the stone in the school building itself, going on to gutters, drainpipes, etc. Soon the biological environment is discussed. A variety of ecological situations are described, and soon the richness of the biological communities in an area such as New York City is unfolded in amazing detail. Then the changes which occur during the year are noted. The booklet concludes with a descriptive listing of the main areas of New York and its rich variety of teaching resources. Urban biology teachers will do well to examine this book. P.K.

FOSSIL PLANTS OF INDIANA, Report of Progress No. 14, James E. Canright, 45 pp., $.75, Indiana Department of Conservation, Geological Survey, Bloomington, Indiana, 1959.

An illustrated booklet for biologists interested in the fossil remains of biological specimens. There is an introduction of geological background, types of fossils, and maps of fossil bed locations. Emphasis is on the coal-forming plants. The booklet concludes with a phylogenetic listing of the fossil plants and illustrations. A handy reference.

P. K.

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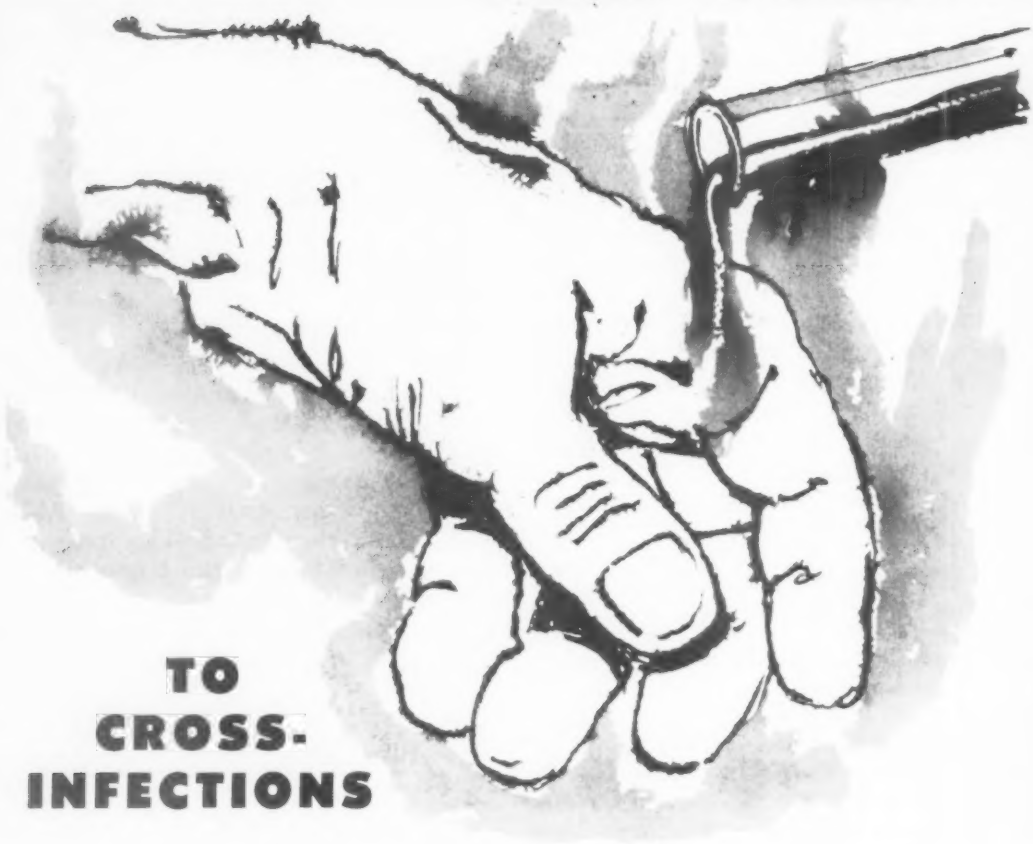

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BARRON'S TEEN-AGE SUMMER GUIDE, M. Reinhold, 148 pp., $1.50, Barron's Educational Series, Inc., Great Neck, New York, 1960.

A very handy paper-back for school counselors and parents. Opportunities are listed for useful summer activities for youngsters 14-18. Liberally illustrated, the topics covered are travel, domestic and foreign, camps, wilderness trips, work camps, summer jobs, study, and a useful appendix listing many opportunities by geographic region. A host of useful tips for teenagers in obtaining these activities.

P. K.

VERTEBRATE DISSECTION, Warren F. Walker, Jr., 340 pp., W. B. Saunders Company, Philadelphia, Pennsylvania, 1960.

This is a laboratory manual for the study of comparative anatomy. The drawings are good, and there is a very informative appendix on preservation of animal specimens. Elaborate dissection instructions are a fine feature.

P. K.

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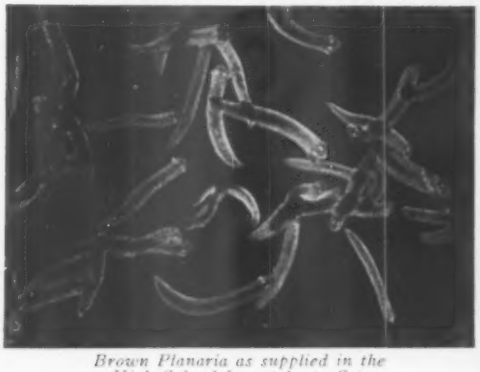

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